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U.S. Army
Environmental
Center

FORT DEVENS FEASIBILITY STUDY
FOR GROUP 1A SITES

FINAL FEASIBILITY STUDY

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
DATA ITEM A009

CONTRACT DAAA15-91-D-0008
DELIVERY ORDER NUMBER 0004

U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MARYLAND

FEBRUARY 1995

PRINTED ON RECYCLED PAPER

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Prepared for:

U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland

Prepared by:

ABB Environmental Services, Inc.
Portland, Maine
Project No. 07005-08

FEBRUARY 1995

FORT DEVENS FEASIBILITY STUDY FOR GROUP 1A SITES
SHEPLEY'S HILL LANDFILL OPERABLE UNIT

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EXECUTIVE SUMMARY

The U.S. Army Environmental Center directed ABB Environmental Services, Inc. (ABB-ES), under Contract No. DAAA15-91-D-0008, to conduct a Feasibility Study to evaluate alternatives to reduce potential human health and ecological risks associated with contaminated groundwater at the Shepley's Hill Landfill Operable Unit at Fort Devens, Massachusetts. The Shepley's Hill Landfill Operable Unit consists of the sanitary landfill incinerator, Area of Contamination (AOC) 4; sanitary landfill No. 1 or Shepley's Hill Landfill, AOC 5; and the asbestos cell, AOC 18. Both AOC 4 and 18 are located within the bounds of the Shepley's Hill Landfill.

Landfill operations at Shepley's Hill Landfill began at least as early as 1917 and stopped as of July 1, 1992. The landfill received household and military refuse, and during its last few years of use, operated using the modified trench method. From 1941 until the late 1940s ash from the sanitary landfill incinerator was buried in the landfill.

In an effort to mitigate the potential for off-site contaminant migration, Fort Devens initiated the Sanitary Landfill Closure Plan in 1984 in accordance with Massachusetts regulations. A four-phase installation of an 84-acre polyvinyl chloride (PVC) geomembrane cap began in 1986 and was completed in early 1993 (Figure ES-1).

The Remedial Investigation Addendum Report evaluated potential human health and ecological risks associated with exposure to contaminants in surface soil and groundwater at the landfill, and surface water, sediments, and fish in nearby Plow Shop Pond, which is interpreted to have received the discharge of landfill contaminated groundwater (ABB-ES, 1993b). Human health risks exceeded the U.S. Environmental Protection Agency (USEPA) points of departure (i.e., risk management guidelines corresponding to cancer risks exceeding $1x10^{-6}$ and noncancer hazard index (HI) values exceeding 1) for the following risk scenarios:

- Residential use of groundwater under future land-use conditions (there is no exposure under current land-use conditions). The primary contributors to risk were the inorganics arsenic, manganese, chromium, lead, nickel, aluminum, iron, and sodium, and the organics 1,2-dichloroethane and dichlorobenzenes.

- Consumption of fish from Plow Shop Pond.
- Direct contact with Plow Shop Pond sediment.

The ecological risk assessment identified potential risks to aquatic and semi-aquatic receptors in Plow Shop Pond. The primary contributors to ecological risk were arsenic, chromium, lead, manganese, and mercury.

Based on the results of the risk assessments, the following remedial action objectives were developed for groundwater at the Shepley's Hill Landfill Operable Unit:

- Prevent potential residential exposure to groundwater containing chemicals in excess of the following site-specific Preliminary Remediation Goals (PRGs): dichlorobenzenes (5 micrograms per liter [μg/L]), 1,2-dichloroethane (5 μg/L), aluminum (6,870 μg/L), arsenic (50 μg/L), chromium (100 μg/L), iron (9,100 μg/L), lead (15 μg/L), manganese (291 μg/L), nickel (100 μg/L), and sodium (20,000 μg/L).
- Prevent off-site migration of groundwater containing chemicals in excess of the above concentrations.
- Prevent contaminated landfill groundwater from contributing to arsenic contamination of Plow Shop Pond sediments in excess of health- and risk-based Applicable or Relevant and Appropriate Requirements (ARARs).
- Meet location-specific and action-specific ARARs.

Because of unresolved issues concerning Plow Shop Pond, the U.S. Army, USEPA, and the Massachusetts Department of Environmental Protection mutually agreed that remedial alternatives to reduce potential risks associated with exposure to contaminated fish and sediments in Plow Shop Pond will be evaluated in an FS for the Plow Shop Pond Operable Unit.

Ten candidate remedial alternatives were developed and screened, and five were evaluated in detail for their ability to meet the remedial action objectives. The matrix shown below presents the major components of each alternative.

Remedial Action	Alternatives									
	SHL-1	SHL-2	SHL-3	SHL-4	SHL-5	SHL-6	SHL-7	SHL-8	SHL-9	SHL-10
Groundwater Monitoring		X	X	X	X	X	X	X	X	X
Institutional Controls		X	X	X	X	X	X	X	X	X
Groundwater Containment			X	X						
Groundwater Barrier					X	X	X	X	X	
Install a RCRA Cap										X
In-situ Oxidation				X				X		
Groundwater Extraction			X		X	X	X		X	
Ion-Exchange Treatment			X or		X					
Chemical Precipitation Treatment			X			X				
Constructed Wetland Treatment							X			
Discharge to Nonacoicus Brook			X		X	X	X			
Discharge to POTW									X	

The candidate alternatives rely heavily on groundwater containment and groundwater barriers in the form of slurry walls, grout curtains, and drains to control and redirect groundwater flow. Because of this, a groundwater model based on the U.S.

Geological Survey modeling code MODFLOW played a major role in the screening of alternatives. The groundwater model indicated that the existing landfill cap will cause a major shift in groundwater flow direction. According to the model, (contaminated) groundwater flow that used to discharge to the cove along the western shore of Plow Shop Pond will turn to the north and leave the site beneath the extreme northern tip of the landfill. Based on this modeling, there would be no benefit from installation of the proposed groundwater containment and barriers. Furthermore, comparison of modeled groundwater elevations under the landfill cap with the ground surface elevation prior to landfilling (i.e., the interpreted lower limit of landfill waste) indicates that waste materials are above the water table. Therefore, Alternative SHL-3 was screened out because its long slurry wall groundwater containment system offered no advantage over the shorter groundwater barrier of Alternatives SHL-5 or SHL-6. The model also indicated that hydrogen peroxide injected into the aquifer as part of the two alternatives, SHL-4 and SHL-8, employing in-situ oxidation, would not mix with groundwater. Alternatives SHL-4 and SHL-8 were screened out because of predicted difficulties with injection and mixing of the in-situ oxidant.

Alternative SHL-6 was screened out because preliminary vendor information indicated that its chemical precipitation treatment system offered no advantages over the ion-exchange of Alternative SHL-5. Alternative SHL-7 was screened out because of concerns about the effectiveness of its constructed wetland treatment system. To maintain a range of candidate alternatives for detailed evaluation, Alternatives SHL-5 and SHL-9 were retained, but were modified by elimination of their slurry wall groundwater barrier. Alternative SHL-10 was retained.

Five candidate alternatives remained after screening. Alternative SHL-1, the No Action alternative, takes no action to reduce potential risks associated with future residential exposure to groundwater. Under this alternative, the U.S. Army would not perform any further closure or post-closure activities. Available groundwater monitoring data indicate that groundwater leaving the site along predicted contaminated water flow paths meets numerical PRGs contained in the remedial action objectives.

Alternative SHL-2, Limited Action, reduces potential risk from potential residential exposure to groundwater by implementing institutional controls in the form of zoning and deed restrictions to limit residential development and residential well placement at the landfill. Because there is no current residential groundwater exposure, and

because the landfill and bordering land are owned by the U.S. Army, there is unique potential for Alternative SHL-2 to be protective of human health. A long-term groundwater monitoring program will monitor downgradient groundwater quality at the site. Available groundwater monitoring data indicate that groundwater leaving the site along predicted contaminated water flow paths meets numerical PRGs contained in the remedial action objectives.

Alternative SHL-5, Collection/Ion Exchange Treatment/Surface Water Discharge, reduces potential risk from groundwater exposure by extracting contaminated groundwater, treating it at an ion exchange treatment facility to be constructed on site, and discharging treated groundwater to Nonacoicus Brook. There are two variants of this alternative, SHL-5A and SHL-5B, that differ only in the location of the proposed extraction well. Under SHL-5A the extraction well would be located at the northern tip of the landfill. Under SHL-5B the extraction well would be located between the landfill and Plow Shop Pond. This latter extraction location would be used if final groundwater flow paths did not conform to groundwater model predictions. Although available groundwater monitoring data indicate that extraction and treatment of groundwater from the north end of the landfill is not needed at this time, inclusion of Alternative SHL-5A provides flexibility in evaluating and selecting an appropriate remedial response. Successful implementation of this alternative would require obtaining a National Pollutant Discharge Elimination System (NPDES) permit for the discharge of treated groundwater to Nonacoicus Brook.

Alternative SHL-9, Collection/Discharge to POTW, is similar to the collection/treatment/discharge approach of Alternative SHL-5. Alternative SHL-9, however, proposes discharge of extracted groundwater to the Town of Ayer Publicly Owned Treatment Works (POTW) for treatment and discharge. Available groundwater monitoring data indicates that extracted groundwater should be able to be discharged to the POTW without pretreatment. Preliminary conversations with POTW representatives indicate that the facility has capacity available to accept the extracted groundwater. Implementation of this alternative would require negotiation of a long-term discharge agreement between the Town of Ayer and the U.S. Army. Similar to Alternative SHL-5, this alternative has two variants SHL-9A and SHL-9B.

Alternative SHL-10, Installation of RCRA Cap, proposes installation of a composite cap consisting of a geomembrane and underlying geosynthetic clay liner on top of the existing cover. Institutional controls and long-term groundwater and landfill gas

monitoring programs similar to those prepared for SHL-2 would also be implemented.

There are no implementation costs associated with Alternative SHL-1. The estimated present worth of Alternative SHL-2 is $2,219,000. The estimated present worth of Alternatives SHL-5A and SHL-5B is $9,126,000. Alternatives SHL-9A and SHL-9B have a present worth of $3,874,000. Alternative SHL-10 has a present worth of $20,936,000.

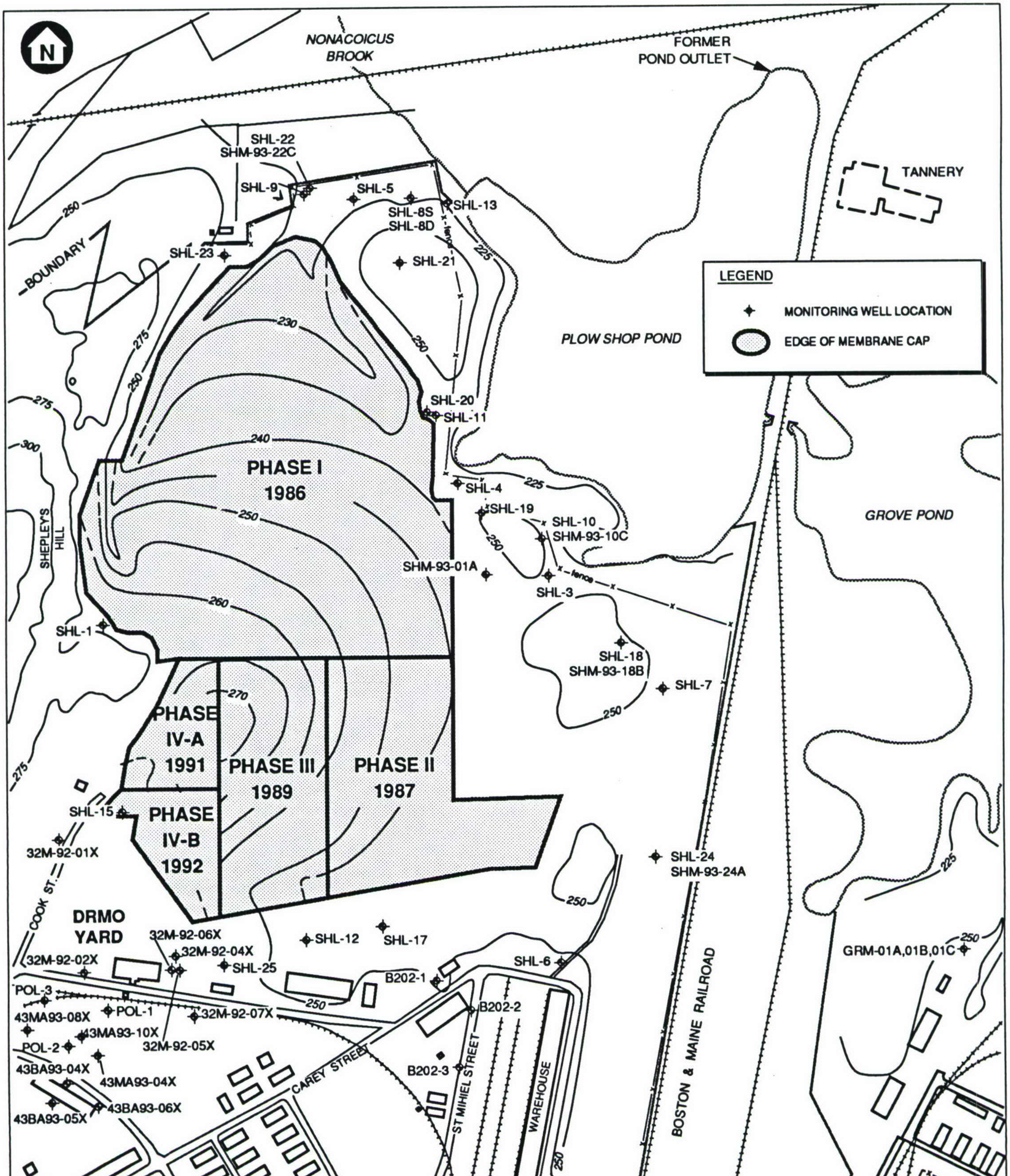

FIGURE ES-1
SHEPLEY'S HILL LANDFILL SITE MAP
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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SECTION 1.0

1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), prepared this Feasibility Study (FS) Report for the Shepley's Hill Landfill Operable Unit as part of the FS effort for Group 1A sites at Fort Devens, Massachusetts. This work was conducted in accordance with the U.S. Army Environmental Center (formerly U.S. Army Toxic and Hazardous Materials Agency) Contract DAAA15-91-D-0008, Delivery Order 0004. The Group 1A sites were identified for investigation in the Fort Devens Master Environmental Plan, and are subject to a Federal Facility Agreement (Interagency Agreement [IAG]) between the U.S. Department of the Army and the U.S. Environmental Protection Agency (USEPA) (USEPA, 1991c). Fort Devens was placed on the National Priorities List (NPL), effective December 21, 1989. This FS was prepared in accordance with USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988b).

The Group 1A sites consist of the sanitary landfill incinerator, Area of Contamination (AOC) 4; sanitary landfill No. 1 or Shepley's Hill Landfill, AOC 5; the asbestos cell, AOC 18; and Cold Spring Brook Landfill, AOC 40. AOCs 5 and 18 are located within the capped area at Shepley's Hill Landfill. The three AOCs are collectively referred to as Shepley's Hill Landfill in this FS report and are included in the Shepley's Hill Landfill Operable Unit. Figure 1-1 shows a Site Location Map for the Group 1A sites.

Fort Devens was identified for closure by the Base Realignment and Closure Act of 1991, and will cease to be an active Army installation on September 30, 1995. Although a small military presence will remain, a major portion of the post will be released for development.

The Administrative Record, which contains documents relating to the Group 1A sites, is available for public review at the Fort Devens Base Realignment and Closure Office and at the Ayer Town Hall.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this FS Report for Shepley's Hill Landfill Operable Unit (AOCs 4, 5, and 18) within the Group 1A sites at Fort Devens, Massachusetts is to:

- establish response objectives, as appropriate, based on actual or potential risks to human health or the environment;
- identify the types of response actions necessary to accomplish response objectives;
- identify and screen specific remedial technologies that may be capable of attaining response objectives;
- develop and evaluate a range of remedial alternatives based on those technologies; and
- compare the alternatives in accordance with evaluation criteria recommended by USEPA.

It is based on information and data presented in the Remedial Investigation (RI) Report prepared by Ecology and Environment, Inc. (E&E, 1993) and the RI Addendum Report prepared by ABB-ES (ABB-ES, 1993b). This report also presents updated information from the Regulatory Draft Preliminary Remedial Technology Screening document (ABB-ES, 1992) and the Draft Alternatives Screening Report (ABB-ES, 1993a). Figure 1-2 is a schematic of the FS process. Alternatives to remediate sediment contamination in the Plow Shop Pond Operable Unit and Cold Spring Brook Landfill Operable Unit will be evaluated in separate documents.

This FS Report consists of six sections. Section 1 provides a brief description and history of the Shepley's Hill Landfill Operable Unit. In addition, it summarizes the nature and extent of contamination and the baseline risk assessment presented in the RI Addendum Report (ABB-ES, 1993b).

Section 2 discusses chemical-specific, location-specific, and action-specific Applicable or Relevant and Appropriate Requirements (ARARs) and their role

in site remediation. Section 3 identifies remedial action objectives and identifies and screens potential remedial technologies.

Section 4 develops and screens potential remedial alternatives for the Shepley's Hill Landfill Operable Unit.

Section 5 contains the detailed analysis of alternatives and Section 6 contains the Comparative Analysis of Remedial Alternatives.

1.2 Site Description and History

The Shepley's Hill Landfill Operable Unit includes three AOCs: AOC 4, the sanitary landfill incinerator; AOC 5, sanitary landfill No. 1 or Shepley's Hill Landfill; and AOC 18, the asbestos cell. The sanitary landfill incinerator was located in former Building 38 near Cook Street within the area included in Phase 1 of the sanitary landfill closure. The incinerator was constructed in 1941. It burned household refuse and operated until the late 1940s. Ash from the incinerator was buried in the landfill. The incinerator was demolished and buried in the landfill in September 1967. The building foundation was removed and buried on site in 1976.

1.2.1 Surficial Geology

Shepley's Hill Landfill lies within the Ayer topographic quadrangle. The surficial geology of the Ayer quadrangle was mapped in 1941 by Jahns (Jahns, 1953). The soils in and around Shepley's Hill Landfill are predominantly unconsolidated, poorly graded fine to medium sands with gravel, cobbles and a silt content ranging between 1 and 15 percent. Soils in the landfill area are part of the Hinckley-Merrimack-Windsor Association and are associated with deposition in glacial Lake Nashua, which formed against the terminus of the Wisconsinan ice sheet. Depositional features include a kame terrace, a glacially deposited hill of stratified sands and gravels, with an elevation of 250 feet above sea level (ASL) located in the northeast corner of the landfill, and prominent cross beds in an exposed channel fill feature 100 feet west of well SHL-7. The uppermost portion of the unconsolidated deposits consists of fine aeolian deposited sand. Palustrine sediments, such as peat, are probably located below fill material in the central and north-central sections of the landfill between Shepley's Hill and the kame plateau.

Maps indicate that these areas were swamps prior to landfilling operations and may have been the result of a small kettle lake. Dense silt, 1 to 10 feet thick, was encountered at the overburden bedrock interface in borings SHL-1, SHL-4, SHL-16, SHL-25 (E&E, 1993), and SHM-93-01A. This silt may represent a till, and contained gravel-to cobble-size pieces of slightly weathered gneiss and phyllite. The unconsolidated overburden reaches a maximum observed thickness of 115 feet at both the northern and southern portions of the landfill. Across the central portion of the landfill the overburden thickness is estimated to range from 25 to 50 feet, dependent on landforms. The overburden over the entire landfill has the general trend of thinning to the west where it abuts the Shepley's Hill outcrop.

1.2.2 Bedrock Geology

The surficial soils at Shepley's Hill Landfill are underlain by low-grade phyllitic metasiltstones and biotite-rich gneiss. The metasiltstone is calcareous, with secondary quartz and sulfides along bedding planes and fractures. Extensive folding, banding, and foliation is also evident. The metasiltstones are only slightly weathered with small (0.1 to 0.5 inch) solution cavities. The bedrock core obtained from SHM-93-10C was moderately fractured in the uppermost 10 feet and became increasingly competent with depth. The fractures occurred chiefly along bedding planes, although some fractures were nearly perpendicular in bedding. The foliation was observed to be dipping at 45 to 50 degrees, but was nearly vertical in areas. The following boreholes encountered metasiltstone: SHL-10, SHL-24 (E&E, 1993), SHM-93-10C, and SHM-93-22C. The bedrock core from SHM-93-22C indicates that bedrock at this location is a low-grade gneiss. The metasiltstones below Shepley's Hill Landfill belong to the Silurian Berwick Formation.

The gneiss, which appears from outcrops to be nonintrusive, is characterized by its high biotite content, gneissic foliation, and elongated feldspathic porphyroblasts. The following boreholes encountered varying metamorphic grades of gneiss: SHL-1, SHL-2, SHL-3, SHL-4, SHL-5, SHL-8, SHL-11, SHL-14, SHL-20, and SHL-22 (E&E, 1993). The gneiss, which is associated with the Devens-Long Pond facies of the Ayer Granite (Upper Ordovician and Lower Silurian) is only slightly weathered. The gneiss directly underlies unconsolidated materials beneath most of the landfill outcropping to the west at Shepley's Hill and to the southwest near the Defense Reutilization and Marketing Office (DRMO) yard and adjacent to

the Petroleum Oil and Lubricants (POL) yard. The 20 feet of gneiss core obtained from SHM-93-22C contained only three natural fractures, all within the uppermost 10 feet. Secondary quartz and quartzite occur throughout the rock along healed fractures. Both open and healed fractures were observed to be dipping at approximately 50 degrees. The Berwick Formation metasiltstone occurs only in the southeast corner of the landfill.

As interpreted in the RI Addendum Report, it appears that a bedrock ridge extends from SHL-1 eastward below Plow Shop Pond (ABB-ES, 1993b). The evidence supporting the existence of the ridge includes the bedrock elevation of 215.7 feet ASL at monitoring well SHM-93-01A. This is 5 feet higher than the bedrock elevation at well SHM-93-10C which is 250 feet to the northeast. This change in elevation would be consistent with the presence of a ridge aligned east-northeastward from Shepley's Hill to below Plow Shop Pond. The results of the seismic survey indicated a bedrock high between wells SHL-3 and SHL-11, with bedrock elevations rising above 200 feet ASL. The seismic survey data may be explained by a local, closed bedrock high not just the presence of a ridge. Exposed bedrock topography also supports the existence of a ridge; the gneiss that comprises Shepley's Hill juts out to the east near SHL-1 along the line of the axis of the inferred ridge. Furthermore, the prelandfill ground surface contours and the presence of a generally coincident topographic high with a superimposed shallow swampy depression suggests a shallow bedrock substrate.

The bedrock topography along the southern boundary of the landfill is characterized by a series of hills and valleys that appear to trend roughly north-south.

Bedrock along the northern end of the landfill is characterized by a deep valley increasing in depth toward Nonacoicus Brook.

1.2.3 Groundwater Hydrology

Groundwater present in the overburden represents the primary aquifer in the Shepley's Hill Landfill area. Groundwater also occurs in the underlying bedrock; however, there is little or no primary effective porosity. Groundwater flow can occur along bedrock fractures and solution cavities.

Groundwater in the area flows primarily from the west-southwest to the east and north (Figure 1-3). Discharge areas for groundwater around the landfill include Plow Shop Pond and the wetland north of West Main Street in Ayer. The presence of the dam in the northwest corner of Plow Shop Pond has raised the pond surface elevation in this area above the groundwater elevation, thereby locally reversing the gradient and causing water to discharge from Plow Shop Pond. The point where the gradient reverses varies seasonally depending on pond and groundwater elevation. Groundwater modeling discussed in Section 4 indicates that this transition occurs in the vicinity of well SHM-93-01A. Groundwater to the north of this point flows north, while groundwater to the south discharges to Plow Shop Pond.

Measured groundwater elevations indicate a groundwater divide exists to the southwest of the landfill below the DRMO yard. The divide occurs along a northwest-southeast trending line between monitoring well 32M-92-07X and Shepley's Hill. Groundwater to the northeast of this divide flows eastward and northeastward under the southern portion of the landfill, while groundwater to the southwest of the divide flows to the southwest away from the landfill. The overburden aquifer appears to be recharged at least in part, by groundwater discharging from the bedrock along the western border of the landfill. The relationship between the bedrock aquifer and the overburden aquifer in the center of the cap is unknown; however, it is possible that the bedrock aquifer may also discharge to the overburden in this area. Vertical hydraulic gradients between the bedrock aquifer and the overburden show an upward gradient of 0.05 feet per foot (ft/ft) between SHM-93-10C and SHL-10 and 0.026 ft/ft between SHL-24 and SHM-93-24A. An upward gradient of 0.004 ft/ft exists between the deep overburden well SHM-93-18B and the water table well SHL-18. A downward gradient of 0.13 ft/ft appears to occur in the northern section of the landfill between the bedrock well SHM-93-22C and the water table well SHL-22. No measurable vertical gradient occurs between SHL-8S and SHL-8D in the northeast corner of the landfill.

Upward vertical gradients are observed along the southeastern and eastern perimeters of Shepley's Hill Landfill as would be expected as groundwater discharges to Plow Shop Pond. A downward gradient and lack of vertical gradient are observed in the northern and northeastern portions of the landfill. This is consistent with Plow Shop Pond discharging to the overburden aquifer because of

the presence of the dam. The groundwater ultimately discharges to the wetland north of West Main Street and to the Nashua River.

The landfill cap covers approximately 84 acres (Biang et al., 1992). The cap has reduced or eliminated infiltration from precipitation, and lowered the water table beneath it. The result of lowering the water table has been to impart a more northerly component of flow in the southern section of the landfill, as shown in Figure 1-3.

Permeability testing of Shepley's Hill Landfill monitoring wells produced hydraulic conductivity estimates ranging from $2x10^{-2}$ centimeters per second (cm/sec) to $5x10^{-4}$ cm/sec for the unconfined overburden aquifer and $3x10^{-5}$ cm/sec to $5x10^{-7}$ cm/sec for the bedrock aquifer (ABB-ES, 1993b).

1.2.4 Shepley's Hill Landfill History

Shepley's Hill Landfill encompasses approximately 84 acres in the northeast corner of the Main Post at Fort Devens. It is situated between the bedrock outcrop of Shepley's Hill on the west and Plow Shop Pond on the east (Figure 1-4). Nonacoicus Brook, which drains Plow Shop Pond, flows through a wooded wetland at the north end of the landfill. The southern end of the landfill borders the DRMO yard and a warehouse area. An area east of the landfill and south of Plow Shop Pond is the site of a former railroad roundhouse.

Review of the surficial geology map of the Ayer Quadrangle (Jahns, 1953) shows that in the early 1940s the active portion of the landfill consisted of approximately 5 acres near the end of Cook Street, near where monitoring well SHL-1 is located. The fill was elongated north-south along a preexisting small valley marked by at least two swamps (probably kettle holes) and lying between the bedrock outcrop of Shepley's Hill to the west and a flat-topped kame terrace to the east with an elevation of approximately 250 feet, adjacent to Plow Shop Pond (E&E, 1993). During the landfilling operation, the valley was obliterated, as was much of the kame terrace, which may have been used as cover material. Background information indicates the landfill formerly operated as an open burning site.

Landfill operations at Shepley's Hill Landfill began at least as early as 1917 and stopped as of July 1, 1992. During its last few years of use, the landfill received

about 6,500 tons per year of household refuse, military refuse, and construction debris, and operated using the modified trench method (Biang, 1992). There is evidence that trenches in the northwest portion cut into previously used areas containing glass and spent shell casings. The glass dated from the mid-nineteenth century to as late as the 1920s. The approximate elevation of the bottom of the waste is estimated at 220 feet ASL at the north end of the landfill, and 225 feet ASL in the central and northeast portions of the landfill, based on pre-landfill surface contours. The maximum depth of the refuse is about 30 feet (DEH, 1985). The average thickness of waste is not documented; however, if the average thickness were 10 feet, the landfill volume would be over 1,300,000 cubic yards. Reports of flammable fluid disposal in the southeast portion of the landfill have not been substantiated by test pits or other research (Biang, 1992). The Army has no evidence that hazardous materials were disposed of in the landfill after November 19, 1980. No waste hot spots or hazardous waste disposal areas were identified during RI or supplemental RI activities (E&E, 1993, ABB-ES, 1993b).

In an effort to mitigate the potential for off-site contaminant migration, Fort Devens initiated the Fort Devens Sanitary Landfill Closure Plan in 1984, in accordance with Massachusetts regulations 310 CMR 19.000. The plan, written by Gale Engineering, was approved by the Massachusetts Department of Environmental Protection (MADEP) in 1985. The closure approval was consistent with 310 CMR 19.00 and contained the following requirements:

- grading the landfill surface to a minimum 2 percent slope in non-operational areas of the landfill and 3 percent in operational areas
- removing waste from selected areas within 100 feet of the 100-year floodplain
- installing a gas venting system
- installing an impermeable cap and covering the cap with sand, gravel, and loam, and seeding to provide cover vegetation and prevent erosion
- implementing a groundwater monitoring program based on sampling five existing monitoring wells every four months

The capping was completed in four phases in accordance with the plan (see Figure 1-4). In Phase I, 50 acres were capped in October 1986; in Phase II, 15 acres were capped in November 1987; and in Phase III, 9.2 acres were capped in March 1989. Phase IV closure of the last 10 acres was accomplished in two steps: Phase IV-A was closed in 1991, and Phase IV-B was closed as of July 1, 1992, although the geomembrane cap was not installed over Phase IV-B until May 1993.

Because of the large area and shallow surface slope of the existing landfill, early phases of the landfill closure were completed with a 2 or 3 percent slope. Slopes were increased to 5 percent in Phase IV-B. Phases I through IV-A were capped with a 30-mil polyvinyl chloride (PVC) geomembrane overlain with a 12-inch drainage layer and 6-inch topsoil layer. At the request of MADEP, the Phase IV-B cap design was modified to a 40-mil PVC geomembrane, a 6-inch drainage layer, and a 12-inch topsoil layer. A landfill gas collection system consisting of 3-inch gas-collection pipes bedded in a minimum 6-inch layer of $1x10^{-3}$ material was installed beneath the PVC geomembrane in all closure phases. Gas vents were installed through the PVC geomembrane at 400-foot centers. A minimum 6-inch cushion/protection layer was maintained beneath the geomembrane. As requested by USEPA and MADEP, four additional groundwater monitoring wells were installed in 1986 to supplement the five in the original groundwater monitoring program.

AOC 4, the sanitary landfill incinerator was located in former Building 38 near the end of Cook Street within the area included in Phase I of the sanitary landfill closure. The incinerator was constructed in 1941, and burned household refuse and operated until the late 1940s. Ash from the incinerator was buried in the landfill. The incinerator was demolished and buried in the landfill in September 1967. The building foundation was removed and buried on-site in 1976.

AOC 18, the asbestos cell, is located in the section of the landfill closed during Phase IV. An estimated 6.6 tons of asbestos construction debris were placed in the section closed during Phase IV-A between March 1982 and November 1985. A new asbestos cell was opened in 1990 in the section closed during Phase IV-B, and was used for disposal of small volumes of asbestos-containing material until July 1992.

1.2.5 Adjacent Areas

Plow Shop Pond is a shallow, 30-acre pond outside the installation boundary, northeast of the landfill. It is the furthest downstream of a chain of six ponds (Long Pond, Sandy Pond, Flannagan Pond, Balch Pond, Grove Pond, and Plow Shop Pond) in the Town of Ayer, and is downstream of Bare Hill Pond, Bowers Brook and Cold Spring Brook in the Town of Harvard. It receives drainage from approximately 17.7 square miles in the towns of Groton, Ayer, and Harvard. Based on comparison to the Nashua River at East Pepperell, the seven-day 10-year (7Q10) low flow in Nonacoicus Brook is approximately 2.6 cubic feet per second.

The eastern shore of Plow Shop Pond is formed by a railroad causeway constructed in the 1800s. A stone arch culvert under the causeway connects the pond with Grove Pond. Water elevation in Plow Shop Pond is controlled at approximately 216 feet ASL by a dam located at the northwest corner of the pond. The central portion of the pond is approximately eight feet deep. A maximum water depth of about 10 feet occurs in the northeast arm of the pond. The discharge from the dam forms Nonacoicus Brook, which flows about 1 mile northwest before its confluence with the Nashua River.

At one time, Plow Shop Pond discharged through a canal, now blocked, at a sawmill at the northeast corner of the pond near the present location of the G.V. Moore Lumber Co. During periods of relatively low stream flow, the Plow Shop Pond dam also controls the water elevation in Grove Pond. However, during periods of high stream flow, the culvert under the railroad causeway restricts flow to Plow Shop Pond, and the elevation of Grove Pond may be 2 feet or more above that of Plow Shop Pond.

The area south of Plow Shop Pond and east of Shepley's Hill Landfill was the site of a railroad roundhouse operated by the Boston and Maine Railroad between 1900 and 1935. Figure 1-5 shows the approximate extent of the former railroad facilities as indicated on a 1934 railroad drawing (B&MRR, 1934), as well as elevation contours at the landfill prior to landfilling. The property formerly occupied by the roundhouse facilities is now owned by the Army. Guilford Transportation Industries operates an extensive, active railyard adjacent to the former roundhouse facilities.

From 1854 through 1961, the area east of the railroad causeway at the northwest corner of Grove Pond was the site of a tannery (Wilson, 1961a,b). The tannery changed ownership several times and operated intermittently between 1900 and 1944. From December 1944, until destroyed by fire in June 1961, this was a successful cattlehide tannery with facilities that included a beam-house for hide unhairing and a tan-house for chrome-tanning.

The tannery is of interest because of its waste disposal practices and its potential as a source of contaminants, especially arsenic, chromium, lead, and mercury, to Grove and Plow Shop ponds. Before 1953, process wastewater from the tannery was discharged to Grove Pond with little or no treatment (Fay, 1993; Taylor, 1953; Power, 1957). In addition, a dump was located on tannery property between the tannery and Grove Pond (Fay, 1993; Fillibrown, 1993; Naparstek, 1993). The dump's specific location is suggested by the gradual filling-in of an embayment in Grove Pond as discernable in aerial photographs taken in 1943, 1952, and 1965 (Detrick, 1991, Figures 14, 15, and 16). As early as 1944, the Town of Ayer and the Commonwealth were concerned about contamination of Grove Pond by the tannery, and in 1949 the town began the process of borrowing funds to connect the tannery to the local wastewater treatment plant (Town of Ayer, 1950; Wilson, 1961a,b); the connection was completed on April 17, 1953 (Taylor, 1953).

Four wetland vegetative cover types were identified within the vicinity of Shepley's Hill Landfill. The wetland cover types and the areas they occupy are identified in Figure 1-6. These areas were identified during the RI by completion of New England Division Army Corps of Engineers Wetland Delineation Data Forms (E&E, 1993). Each wetland cover type meets the three criteria (i.e., hydrophytic vegetation, hydric soils, and wetland hydrology) necessary to be classified as jurisdictional wetland. The 222-feet contour shown in Figure 1-6 defines the edge of the 100 year floodplain. Except for the areas north of the landfill, the floodplain occupies approximately the same area as the delineated wetlands.

1.3 Nature and Extent of Contamination

The RI and supplemental RI at the Group 1A sites assessed environmental contamination in the following media at Shepley's Hill Landfill:

MEDIUM	INTERPRETED CONTAMINANT CLASSES
Source Area Soils	None
Source Area Groundwater	Volatile Organic Compounds (VOCs), Inorganics
Plow Shop Pond Sediments	Semivolatile Organic Compounds (SVOCs), Pesticides, Inorganics
Plow Shop Pond Surface Water	VOCs, Inorganics

Sources: E&E, 1993; ABB-ES, 1993b

Soils. Three surface soil samples were collected from suspected seep areas in 1991 during the RI and analyzed for Target Compound List (TCL) organics, Target Analyte List (TAL) metals, and total organic carbon (TOC). Low concentrations of acetone and methylene chloride were reported in the samples; however, they were attributed to laboratory contamination. No other organics were detected. Concentrations of TAL metals were within the estimated background range, except for calcium, which was elevated slightly. This was not considered significant (E&E, 1993). Because soil contamination was not identified during the RI, soils were not sampled during the supplemental RI in 1992.

Groundwater. Groundwater quality was assessed through two rounds of sampling at 22 wells during the RI, and one confirming round at 27 wells plus a second round at five new wells during the supplemental RI. Target analyte groups for the two field programs are listed below.

Analyte Groups	Field Program RI	Field Program Supplemental RI
VOCs	X	X
SVOCs	X	
Pesticides and polychlorinated biphenyls (PCBs)	X	X
Explosives	X	X
Total Inorganics	X	X
Dissolved Inorganics		X
Anions	X	

Sources: E&E, 1993; ABB-ES, 1993b

The RI Report concluded that groundwater downgradient of the landfill was contaminated with VOCs and inorganics as well as low concentrations of explosives, pesticides, and PCBs in scattered wells. The presence of pesticides was not certain, however, because of apparent laboratory contamination of several method blanks. The PCB Aroclor-1260 was found at a low concentration in only one sample in one sampling round. The SVOC di-ethylphthalate was reported at 12 and 32 micrograms per liter (μg/L) in samples from two separate wells and was considered a sampling artifact (E&E, 1993).

The RI Addendum Report identified three groups of monitoring wells: a southern cross-gradient group, a downgradient group, and a northern cross-gradient group (Table 1-1). Mild exceedances of background concentrations for inorganics were noted in the cross-gradient wells, indicating that sources other than Shepley's Hill Landfill may have degraded groundwater quality in the area.

Downgradient wells exhibited contamination with several VOCs and inorganics. Groundwater analytes exceeding background concentrations are listed in Table 1-2. Organic compounds were reported most frequently and at the highest concentrations in wells SHL-10, SHL-11, SHL-20, and SHM-93-10C along the eastern edge of the landfill. Inorganics were also reported at the highest

concentrations in these wells, especially SHL-10, SHL-11, and SHL-20. Of particular interest is the influence of total suspended solids (TSS) on inorganic concentrations. Review of analytical results in the RI Addendum Report shows that a significant portion of the total concentration of inorganics is typically associated with suspended material. However, in wells SHL-11, SHL-19, and SHL-20, high dissolved arsenic concentrations were associated with low oxidation potential (Eh) and/or high pH, indicating that these conditions may have mobilized the arsenic. Table 1-3 provides average and maximum concentrations of VOCs and inorganics in downgradient wells at Shepley's Hill Landfill.

No pesticides or PCBs were reported in the supplemental groundwater samples. This supports the RI Addendum Report reinterpretation of groundwater data presented in the final RI report. Although pesticides were reported at low concentrations in several RI samples, no well had a hit in both RI sampling rounds. In addition, Subsection 5.1.6.3 of the final RI report states that several pesticides including heptachlor, endrin, alpha- and beta-benzenehexachloride (BHC), 2,2-bis(para-chlorophenyl)-1,1,1-trichloroethane (DDT), and endosulfan sulfate were detected in method blank samples and that low concentrations of those compounds should be considered laboratory contamination. Analytical difficulties were noted for PCBs. Subsection 5.2.6.3 of the final RI report also indicates difficulties with the pesticides analysis. These considerations and the supplemental RI data support the conclusion that the landfill is not a source of pesticides or PCBs in groundwater.

The explosive nitroglycerine was reported in one monitoring well, the water table well SHM-93-24A, at 80.8 μg/L. This well is considered cross-gradient of the landfill and the source of the nitroglycerine is not known. The landfill is not considered a source of nitroglycerine. The explosives 1,3,5-trinitrobenzene, 1,3-dinitrobenzene and tetryl were reported inconsistently and at low concentrations in RI samples, they were not detected in the supplemental RI samples. SVOCs were not identified as groundwater contaminants in the RI report or targeted as analytes during the supplemental field program. They are not considered groundwater contaminants at Shepley's Hill Landfill.

<u>Plow Shop Pond Sediments</u>. Plow Shop Pond is believed to have been an historical discharge area for groundwater passing beneath Shepley's Hill Landfill and to have received contamination from the landfill. The characterization of Plow Shop Pond sediments was accomplished during both the RI and

supplemental RI. RI sampling involved collection and analysis of shallow (0 to 6-inch depth) samples for TCL organics, TAL metals, and TOC. The RI Report concluded that pond sediments were contaminated with high concentrations of TAL metals and low concentrations of several polynuclear aromatic hydrocarbons (PAHs). The VOCs acetone, methylene chloride, and 2-butanone were reported in several samples, as were low concentrations of 2,2-bis(para-chlorophenyl)-1,1-dichloroethene (DDE) and heptachlor (E&E, 1993). The presence of acetone, methylene chloride, and heptachlor is attributed to laboratory contamination.

During the supplemental RI, sediment samples (0 to 1-foot depth) were collected at 28 locations and analyzed for Project Analyte List (PAL) pesticides, PCBs, and inorganics. The RI Addendum Report concluded that sediments were contaminated with arsenic, barium, copper, chromium, iron, lead, manganese, mercury, nickel, and zinc. Based on manufacturing process chemicals, waste disposal practices, and chemical distribution patterns in Grove and Plow Shop Ponds, the tannery located on Grove Pond was identified as the major source of arsenic, chromium, lead, and mercury. Shepley's Hill Landfill was identified as a primary source of barium, iron, manganese, and nickel and a secondary source of arsenic, chromium, and lead. Additional data are needed to define the source of copper. The supplemental sampling confirmed the presence of 2,2-bis(para-chlorophenyl)-1,1-dichloroethane (DDD), DDE, and DDT at low concentrations in pond sediments. The chemicals exceeding Ontario Ministry of the Environment sediment guidelines (Persaud, 1992) are listed in Table 1-2. The RI Addendum Report did not identify the landfill as a source of the pesticides. Potential remedial actions for Plow Shop Pond sediment contamination will be evaluated in a separate FS for the Plow Shop Pond Operable Unit.

Surface Water. During the RI, samples were collected from 13 locations along the Plow Shop Pond shoreline to characterize surface water quality. Target analytes included TCL organics and TAL metals. The VOCs chloroform and methylene chloride were reported in several samples, and the pesticide endrin detection was reported at a low concentration in one sample. Methylene chloride was considered a laboratory contaminant and the endrin detection was not considered significant in the RI Report. The presence of chloroform, considered an improbable surface water contaminant in the RI Report, could not be explained. The inorganics copper, silver, and zinc exceeded Ambient Water Quality Criteria (AWQC) for the protection of aquatic life throughout the pond,

and iron and zinc exceeded AWQC in the wetlands area north of the pond (E&E, 1993) (see Table 1-2).

Nonacoicus Brook Wetland. Two surface water/sediment pair samples were collected from Nonacoicus Brook and the wetland area immediately north of the Shepley's Hill Landfill during the RI and analyzed for TCL organics, TAL inorganics, and general analytical parameters (E&E, 1993). In surface water the only reported organics were alpha-benzenehexachloride and methylene chloride; however, the alpha-benezenehexachloride was not confirmed and the methylene chloride was attributed to laboratory contamination. The RI report concluded that concentrations of TAL inorganics in the two samples were generally similar to average concentrations in Plow Shop Pond surface water, although concentrations of barium, iron, and manganese were somewhat greater. The only organic compound reported in the two sediment samples was methylene chloride and it was attributed to laboratory contamination (E&E, 1993). The RI report did not note unusual or high concentrations of TAL inorganics in the two sediment samples.

During supplemental RI activities, surface soil and shallow groundwater samples were collected from four shallow, hand-dug pits in the area immediately north of the landfill (ABB-ES, 1993b). All the samples were analyzed for PAL VOCs, pesticides, PCBs, explosives, and inorganics as well as several general analytical parameters. No PAL organics were reported in the water samples. Concentrations of 14 inorganics in unfiltered groundwater samples exceeded background concentrations; however, the RI Addendum Report concluded that the high concentrations resulted from high TSS concentrations in the samples and that the dissolved contaminant load was low. Barium, calcium, potassium, manganese, lead, and zinc were considered contaminants in shallow groundwater.

No PAL VOCs, PCBs, or explosives were reported in the soil samples. Low concentrations of the pesticides DDE and DDT were reported in two of the total of eight soil samples. A total of 20 PAL inorganics were detected in the soil samples, and concentrations of 16 exceeded background concentrations at least once. After consideration of detection frequency and reported concentration, chromium, mercury, beryllium, silver, copper, and zinc were considered contaminants in the soil samples. Concentrations of chromium and mercury were highest in the samples collected near Nonacoicus Brook and their presence was attributed to historical brook overflows. The influence of Shepley's Hill Landfill

on inorganic concentrations in soil was not clear. The RI Addendum Report concluded that the sampled area was not a major discharge area for contaminated groundwater (ABB-ES, 1993b).

1.4 Summary of Human Health Risk Assessment

A supplemental risk assessment was performed for Shepley's Hill Landfill in the RI Addendum Report (ABB-ES, 1993b) to update the RI Risk Assessment completed in April 1993 (E&E, 1993). Figures 1-7 through 1-10 present risk estimates produced in the Supplemental Risk Assessment relative to USEPA risk management guidelines corresponding to cancer risks exceeding $1x10^{-6}$ and noncancer Hazard Index (HI) values exceeding 1. The risk estimates shown in Figures 1-9 and 1-10 for residential groundwater use are updated from those contained in the Supplemental Risk Assessment (ABB-ES, 1993b). The spreadsheets included in Appendix K of the Final RI Addendum Report erroneously contained a factor for shower exposure time (ET). Figures 1-9 and 1-10 show risk estimates that do not include the factor ET.

Actual fish tissue analyses obtained through the October 1992 fish sampling program measured Chemical of Potential Concern (COPC) levels in fish. (The RI Risk Assessment estimated concentrations of COPCs in fish tissue by multiplying measured sediment concentrations by bioaccumulation factors.) The health risks faced by a recreational fisherman or family member who consumes fish from Plow Shop Pond ranged from $3x10^{-6}$ to $4x10^{-4}$. Arsenic in the fish accounts for approximately 96 to 99 percent of the total risk. Mercury, a COPC not considered to be landfill-related, presented noncancer risks above the regulatory guideline of one (hazard quotients [HQs] range from 2 to 7). Detected concentrations of mercury in the bullhead and bass fillets in Plow Shop Pond also exceeded the U.S. Food and Drug Administration (USFDA) action level for mercury of 1 part per million (ppm). One additional COPC not related to the landfill, DDE, presented a cancer risk of $2x10^{-6}$, which represents only 0.4 to 4 percent of the total risk.

While the risk estimates associated with arsenic in Plow Shop Pond fish do exceed the USEPA points of departure, the risk estimates are thought to overestimate the true risks. Arsenic in fish exists largely as organic forms that possess minimal inherent toxicity and are believed to possess no mutagenic or carcinogenic

potential. For the risk calculations of the RI Addendum Report, all of the arsenic in Plow Shop Pond fish was assumed to be inorganic; the analytical methods for inorganics used in the Supplemental RI did not distinguish between the organic and inorganic forms of a metal. Furthermore, the cancer slope factor for inorganic arsenic is thought by many to overestimate the true risk. The USEPA Integrated Risk Information System (IRIS) file (December 1993) on inorganic arsenic states that "the uncertainties associated with ingested arsenic are such that estimates could be modified downwards as much as an order of magnitude, relative to risk estimates associated with most other carcinogens." If a modifying factor of 10 were applied to the unmodified risk estimates for the fish ingestion pathway, modified cancer risk estimates would range from $3x10^{-7}$ to $4x10^{-5}$ -- risks within or below the Superfund target risk range of $1x10^{-6}$ to $1x10^{-4}$. Because the true risks associated with arsenic in Plow Shop Pond are thought to be significantly lower than initially calculated, it appears that the major health risk associated with Plow Shop Pond fish is due to mercury contamination.

In the Supplemental Risk Assessment, ingestion of and direct contact with sediment presented average and Reasonable Maximum Exposure (RME) cancer risks (unmodified to account for the uncertainty associated with arsenic) ranging from $2x10^{-5}$ to $2x10^{-4}$, respectively, under current land use, and $9x10^{-5}$ to $6x10^{-4}$, respectively, under future land use. Arsenic is responsible for essentially 100 percent of the risk. These risks are above the USEPA point of departure of $1x10^{-6}$ but, under average exposure conditions, within the Superfund target risk range of $1x10^{-6}$ to $1x10^{-4}$. Only under RME conditions does the cancer risk exceed the upper end of the target risk range (at $2x10^{-4}$ and $6x10^{-4}$). If the modifying factor of 10 were applied to the cancer risk estimates for arsenic, cancer risk estimates would range from $2x10^{-6}$ to $2x10^{-5}$ (under current land use) and $9x10^{-6}$ to $6x10^{-5}$ (under future land use); these risks are within the Superfund target risk range.

Cadmium was reported in the RI Risk Assessment to present an assumed health risk of potential concern in Plow Shop Pond fish. However, cadmium was not detected in the bluegills or bullhead and bass fillets in Plow Shop Pond that were evaluated in the Supplemental Risk Assessment and was not a COPC in fish tissue.

The health risks from lead in Plow Shop Pond fish or sediment could not be estimated quantitatively in the Supplemental Risk Assessment because of the lack

of a USEPA-approved dose/response value for lead. Lead was detected in one of five bluegills in Plow Shop Pond, but not in the bullhead or bass fillets. The concentrations of lead in sediment were evaluated using the USEPA interim soil cleanup level for lead for residential settings of 500 micrograms per gram ($\mu g/g$). Although the maximum detected concentration of lead in Plow Shop Pond (632 $\mu g/g$) sediment was above this soil lead cleanup level, the average concentration of lead in Plow Shop Pond was 125 $\mu g/g$. Exposure to lead in sediment at Plow Shop Pond was also predicted to be much less than in a residential setting. Therefore, lead was not predicted to pose a significant health risk in Plow Shop Pond sediment.

Groundwater sampling data from the March and June 1993 sampling rounds (reported in the RI Addendum Report) confirmed the RI Risk Assessment conclusion that the health risks associated with residential use of the groundwater exceed the USEPA points of departure and Superfund target risk range. The cancer risks (unmodified to account for the uncertainty associated with arsenic) from groundwater consumption (from Well Group 1) range from $4x10^{-4}$ to $8x10^{-3}$. Most of the risk was due to the presence of arsenic. The HQs for manganese at average (2,400 $\mu g/L$) and maximum (9,650 $\mu g/L$) exposure concentrations exceed one; they ranged from 12 to 55. The two organic analytes, 1,2-dichloroethane and dichlorobenzenes, presented cancer risks of $1x10^{-5}$ and $6x10^{-6}$, respectively -- within the Superfund target risk range. If the downward modifying factor of 10 were applied to the unmodified cancer risk estimates for arsenic, the modified risks would range from $4x10^{-5}$ to $8x10^{-4}$. It should be noted that even when the concentration of arsenic in groundwater is assumed to be at the federal Maximum Contaminant Level (MCL) of 50 $\mu g/L$, the cancer risk associated with the MCL ($1x10^{-3}$) exceeds the Superfund target risk range and its HQ (of 5) exceeds one.

In the Supplemental Risk Assessment, using the latest groundwater samples (from the two Supplemental RI sampling rounds) and a landfill well grouping slightly different from the RI well group, three compounds besides arsenic contribute to the total risk at risk levels above the USEPA points of departure - 1,2-dichloroethane, dichlorobenzenes, and manganese. Although benzene was detected in the Supplemental RI sampling (in 3 of 14 samples), it does not present a cancer risk above the USEPA point of departure. Chloroform was detected, but considered an artifact of decontamination procedures. Chloroform was not a COPC in the Supplemental Risk Assessment.

In comparing the March and June 1993 sampling results to drinking water standards, for Well Group 1, the maximum detected concentrations of several analytes in unfiltered groundwater exceeded a primary (or health-based) federal or state drinking water standard. These included: 1,2-dichloroethane, dichlorobenzenes, arsenic, chromium, lead, and nickel. Based on filtered samples, however, the maximum concentration of lead was below the federal Safe Drinking Water Act action level. Neither chromium nor nickel were detected in filtered samples. Dichlorobenzenes (isomers unidentified) were detected in one of 14 samples; while the maximum detection exceeded the Commonwealth of Massachusetts drinking water guideline for p-dichlorobenzene (the isomer with the lowest guideline), the average concentration (5.4 μg/L) approximated the guideline (5 μg/L). While the maximum detected concentration of 1,2-dichloroethane (9.9 μg/L) exceeded the federal MCL of 5 μg/L, the average concentration of 0.97 μg/L did not exceed the MCL. Secondary Maximum Contaminant Levels (SMCLs), standards developed to protect against unacceptable aesthetic effects (such as appliance or clothes staining, or taste), were exceeded for aluminum, iron, and manganese. The federal and Commonwealth guidelines for sodium in drinking water were also exceeded. Sodium guidelines have been set for people on sodium-restricted diets.

In summary, the Supplemental Human Health Risk Assessment identified the following potential human health risks:

- Consumption of fish from Plow Shop Pond contaminated with mercury and, to a much lesser degree, with arsenic
- Direct contact with arsenic in Plow Shop Pond sediment
- Future residential use of unfiltered groundwater interpreted to be under the influence of the landfill and contaminated with several inorganics (arsenic, manganese, chromium, lead, nickel, and sodium) and 1,2-dichloroethane and dichlorobenzenes

A human health Preliminary Risk Evaluation (PRE) was performed for the Nonacoicus Brook Wetland area north of Shepley's Hill Landfill, and is contained in Appendix X of the RI Addendum Report (ABB-ES, 1993b).

The human health PRE compared detected concentrations to conservative standards and concluded that they did not present significant public health risk. Although four inorganics detected in shallow groundwater exceeded their respective drinking water guidelines (aluminum, iron, lead, and manganese), only the drinking water guideline for lead and the MCLG for manganese were based on health-protective endpoints. Analyte concentration exceedances of aluminum and iron guidelines, which are derived for aesthetic or economic reasons, may not be indicative of a health risk. In addition, because the groundwater was obtained from test pits at two-to-three foot depths, it was not considered representative of groundwater that would be used for drinking water, thereby making drinking water guidelines conservative standards for comparison.

Arsenic and beryllium both exceeded Region III risk-based soil concentrations; however, arsenic did not exceed the MADEP S-1/GW-1 standard and beryllium, which was detected in only one sample, only slightly exceeded the S-1/GW-1 standard. These standards are for a residential setting with soil frequently being contacted by sensitive receptors. It is likely that the Nonacoicus Brook forested wetland area will not be used for residential (or commercial) purposes.

1.5 Summary of Ecological Risk Assessment

A Supplemental risk assessment was performed at the Shepley's Hill Landfill to update the ecological risk assessment of the RI Report (E&E, 1993). The supplemental ecological risk assessment integrated information gathered from several phases of investigation at the Group 1A Sites in order to determine whether environmental contaminants may pose a risk to ecological receptors. Specifically, the supplemental risk assessment evaluated sediment and fish tissue analytical data that were unavailable when the RI Report was produced. Available surface water analytical data and macroinvertebrate community data were used to characterize risk to aquatic and semi-aquatic receptors. No additional evaluation of surface soils or groundwater was included in the supplemental ecological risk assessment.

The risk assessment of the RI Report indicated that sediment contamination from landfill-derived inorganic analytes in Plow Shop Pond may pose a risk to ecological receptors (E&E, 1993). Arsenic was found to be the primary risk

contributor to aquatic and semi-aquatic biota. Risks to aquatic biota were also predicted from cadmium.

In order to further evaluate ecological risk from the Shepley's Hill Landfill, analytical chemistry data from 41 shallow sediment samples and 15 individual whole fish (representing 3 species) were evaluated in the supplemental risk assessment. Appendix E contains a Wetlands Functional Assessment report (updated from the RI Addendum Report) that characterizes the habitat at Plow Shop Pond.

Average and maximum Plow Shop Pond fish tissue analyte concentrations were compared to regional and national data-bases by trophic level for landfill analytes (as assessed in the Final RI Addendum Report) and other analytes.

The average fish tissue concentration from Plow Shop Pond exceeded regional averages for the following analytes: DDE, aluminum, mercury, and zinc, and the landfill related analytes iron and manganese. The mean whole body concentrations of aluminum, iron, manganese, and zinc in Plow Shop Pond fish were significantly greater ($P < 0.05$) than mean concentrations from the regional database. The maximum Plow Shop Pond whole fish tissue concentrations of cadmium, copper, mercury, and the landfill related analyte arsenic exceeded their respective National Contaminant Biomonitoring Programs (NCBMP) 85th percentile concentrations. Fish body weight (and concomitantly trophic status) appears to be a good predictor of mercury contaminant burden in Plow Shop Pond, with higher trophic level fish species having accumulated higher concentrations of this analyte.

A total of 193 fish representing seven families and 12 species were collected in Plow Shop Pond. Top predators, including the largemouth bass and chain pickerel, represented more than 10% of the total numbers of animals collected. Omnivores and insectivores were also well represented in Plow Shop Pond. Based on the data collected in this study, the species composition and taxa richness of Plow Shop Pond is typical of a southern New England warm water fish community. A gross pathological examination of fish from Plow Shop Pond suggests that the individuals from the population examined are healthy. No tumors, lesions, or other significant abnormalities were observed in any fish examined.

The macroinvertebrate sampling program at Shepley's Hill Landfill was designed to provide baseline information regarding the biota associated with aquatic habitats in Plow Shop Pond. Although some uncertainty was associated with the use of New Cranberry Pond as a reference pond, the macroinvertebrate community data suggest that Plow Shop Pond may be slightly impacted relative to New Cranberry Pond. In particular, the macroinvertebrate statistical analysis indicates that Plow Shop Pond may have a significantly lower taxa richness than New Cranberry Pond, the reference site. The study also indicated that New Cranberry Pond may have more pollution-intolerant species than Plow Shop Pond; Plow Shop Pond had a significantly higher percentage of pollution-tolerant dominant taxa in the vegetated substrate. Lastly, the macroinvertebrate sampling station farthest from the landfill at Plow Shop Pond appeared to have greater macroinvertebrate biodiversity than stations closer to the landfill.

Water quality parameters did not appear to be influencing factors in the differences observed between the macroinvertebrate communities at the two ponds or at the different stations within a pond. A statistical analysis between sediment chemistry data and macroinvertebrate abundance was generally inconclusive. However, the analysis did suggest that a group of approximately 15 inorganic COPCs may collectively impact the macroinvertebrate community adversely, with arsenic, cobalt, iron, manganese, and mercury being the COPCs of greatest concern.

This information suggests that the macroinvertebrate community in Plow Shop Pond, particularly in the vicinity of the landfill, may be slightly impaired relative to that of New Cranberry Pond. However, as discussed in the Final RI Addendum Report (ABB-ES, 1993b), considerable uncertainty is associated with the interpretation of the results of the Group 1A macroinvertebrate study. Limited numbers of samples, uncertainties associated with the selected reference pond, differences in habitat types between ponds, and natural environmental stochasticity make it difficult to draw conclusions from this portion of the supplemental risk assessment.

Concentrations of all five landfill-related analytes (arsenic, barium, iron, manganese, and nickel), as assessed in the Final RI Addendum Report, exceeded the available sediment quality criteria or guidelines. The average exposure HQ for arsenic was 14.2, whereas the RME HQ for this analyte was 97. Average

exposure and RME HQs for the other landfill analytes ranged from 1.5 to 128. Other non-landfill related COPCs in Plow Shop Pond sediments were also present in concentrations in excess of their Reference Toxicity Values (RTVs). HQs ranged from slightly higher than 1 to an RME HQ of 867, for mercury. The RME HQs for cobalt, cadmium, chromium, copper, lead, and zinc were also greater than 1, and ranged from 1.1 (cobalt) to 125 (chromium). For aquatic receptors, approximately 15% of the average exposure HI for Plow Shop Pond is attributable to landfill analytes in sediments. The remaining 85% of the average exposure HI is due to parameters from sources other than the Shepley's Hill Landfill, with mercury being the primary risk contributor.

Neither average nor maximum surface water concentrations of landfill-related analytes, as assessed in the Final RI Addendum Report, exceeded chronic or acute AWQC. Average concentrations of copper and silver exceeded their respective chronic AWQC. Maximum surface water concentrations of copper, silver, and zinc exceeded their respective acute AWQC. HQs ranged from 1.2 (zinc RME) to 7.4 (copper RME).

For semi-aquatic wildlife, exposure to RME concentrations of arsenic in Plow Shop Pond sediment and fish tissue resulted in HQs greater than 1 for four of the eight receptor species evaluated in the food web model, including the mallard duck, painted turtle, green frog, and muskrat. Only the mallard duck was at risk from the average scenario. One other landfill contaminant (manganese) had an HQ in excess of 1; RME to manganese resulted in an HQ of 5 for the mink. Average and RME exposure to mercury and chromium, both non-landfill-related COPCs in Plow Shop Pond sediments, were also presumed to result in risks to semi-aquatic receptors, with HQs greater than 1 for the great blue heron, muskrat, mallard, mink, painted turtle, and green frog.

These findings suggest that contaminants in Plow Shop Pond may be posing a risk to aquatic and semi-aquatic receptors. Analytes from Shepley's Hill Landfill and from sources other than the Shepley's Hill Landfill are ecological risk contributors to aquatic and semi-aquatic receptors in Plow Shop Pond. Primary risk contributors in Plow Shop Pond include arsenic, chromium, lead, manganese, and mercury.

Additionally, although not quantitatively evaluated, possible impacts to vegetation at Plow Shop Pond were observed during a 1993 site visit. Limited qualitative

evidence suggests that aquatic plant life in the northern cove, and to a lesser extent in the southern cove, is sparse relative to the rest of Plow Shop Pond. It is unknown whether these potential differences are due to contaminant exposure.

A ecological PRE performed for the Nonacoicus Brook wetland area north of Shepley's Hill Landfill concluded that there was not a significant ecological risk in that area (ABB-ES, 1993b).

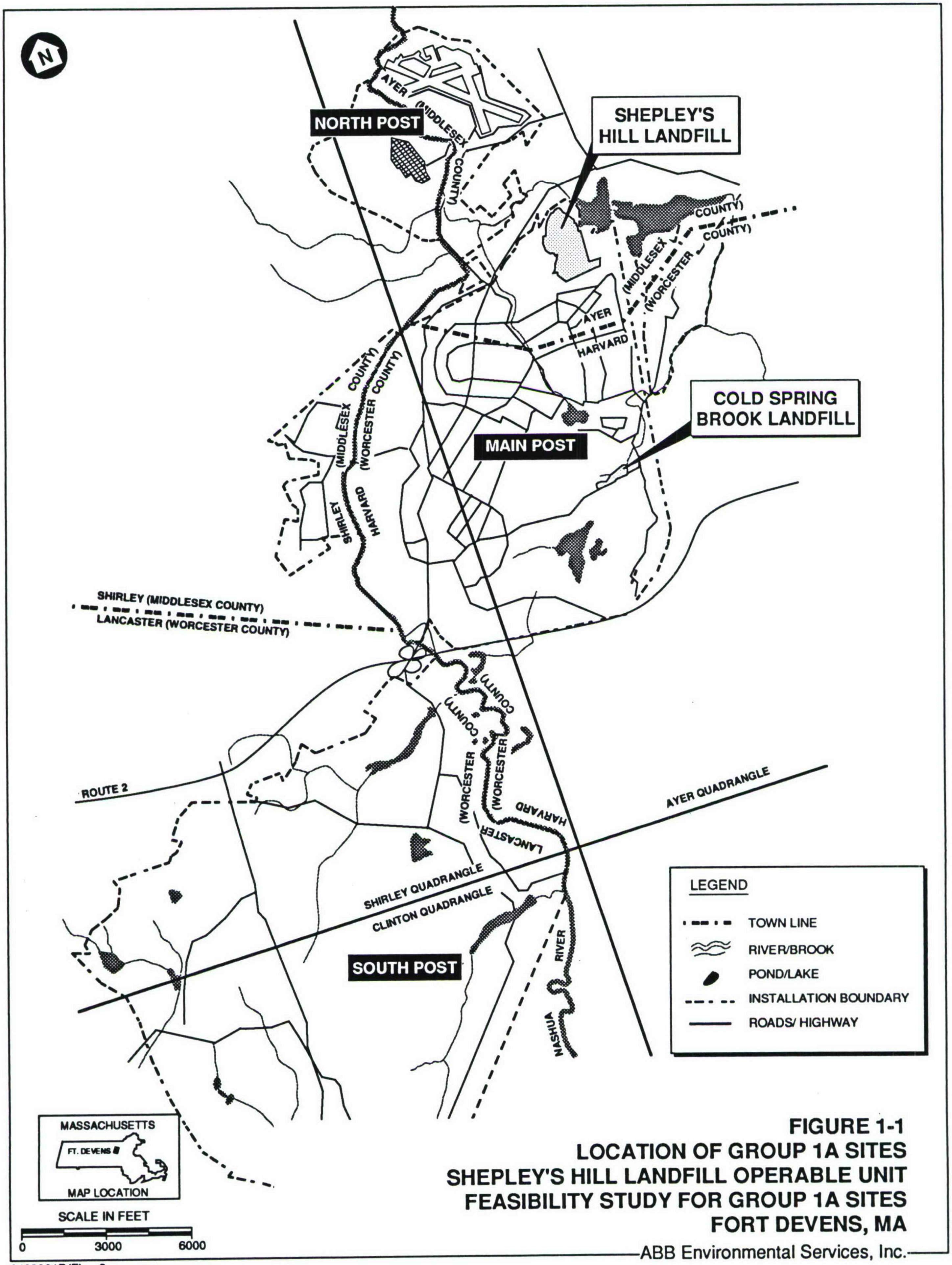

FIGURE 1-1
LOCATION OF GROUP 1A SITES
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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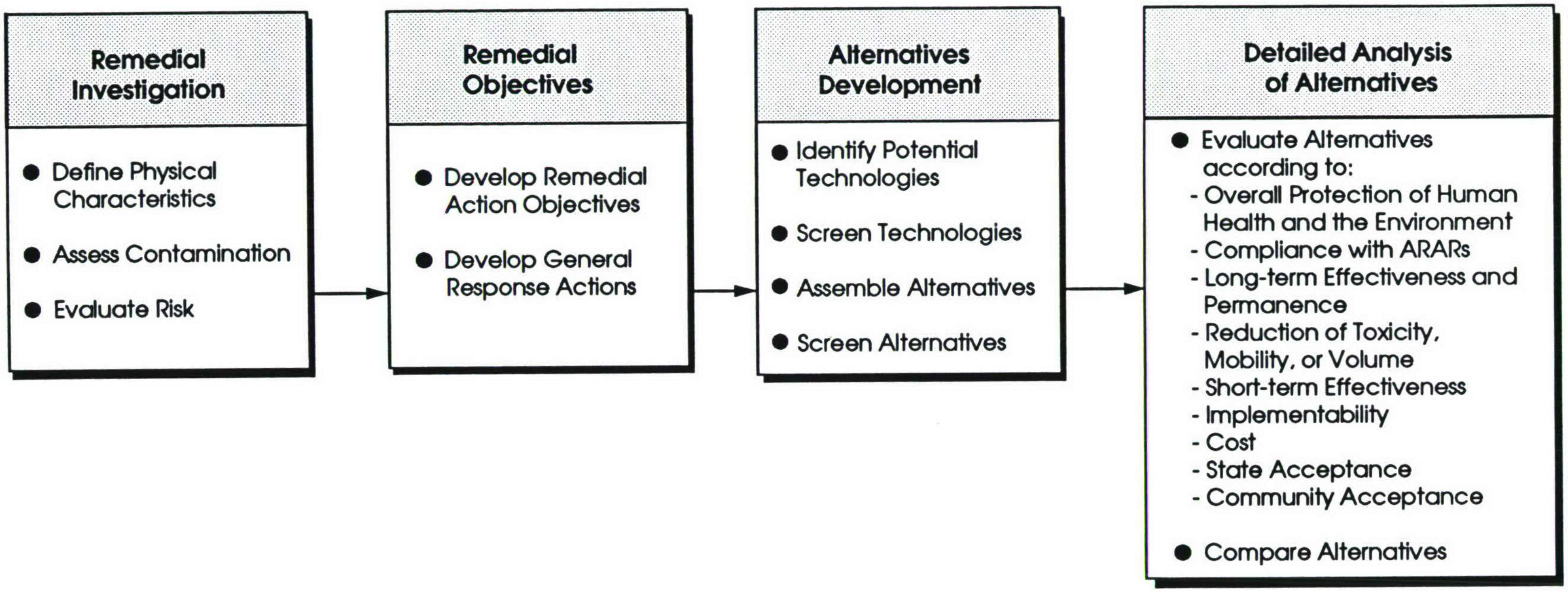

FIGURE 1-2
FEASIBILITY STUDY PROCESS
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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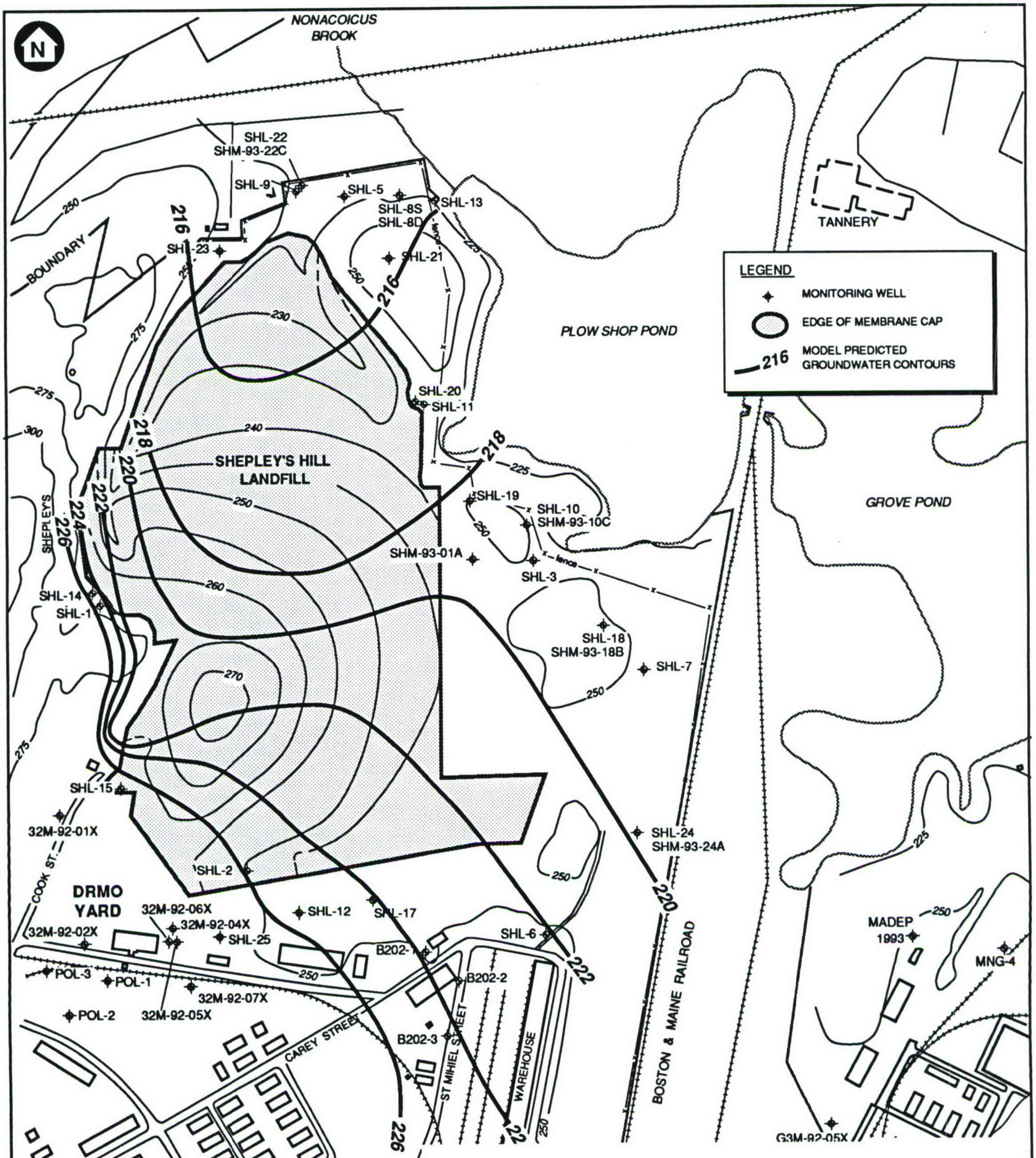

FIGURE 1-3
MODEL PREDICTED GROUNDWATER CONTOURS
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
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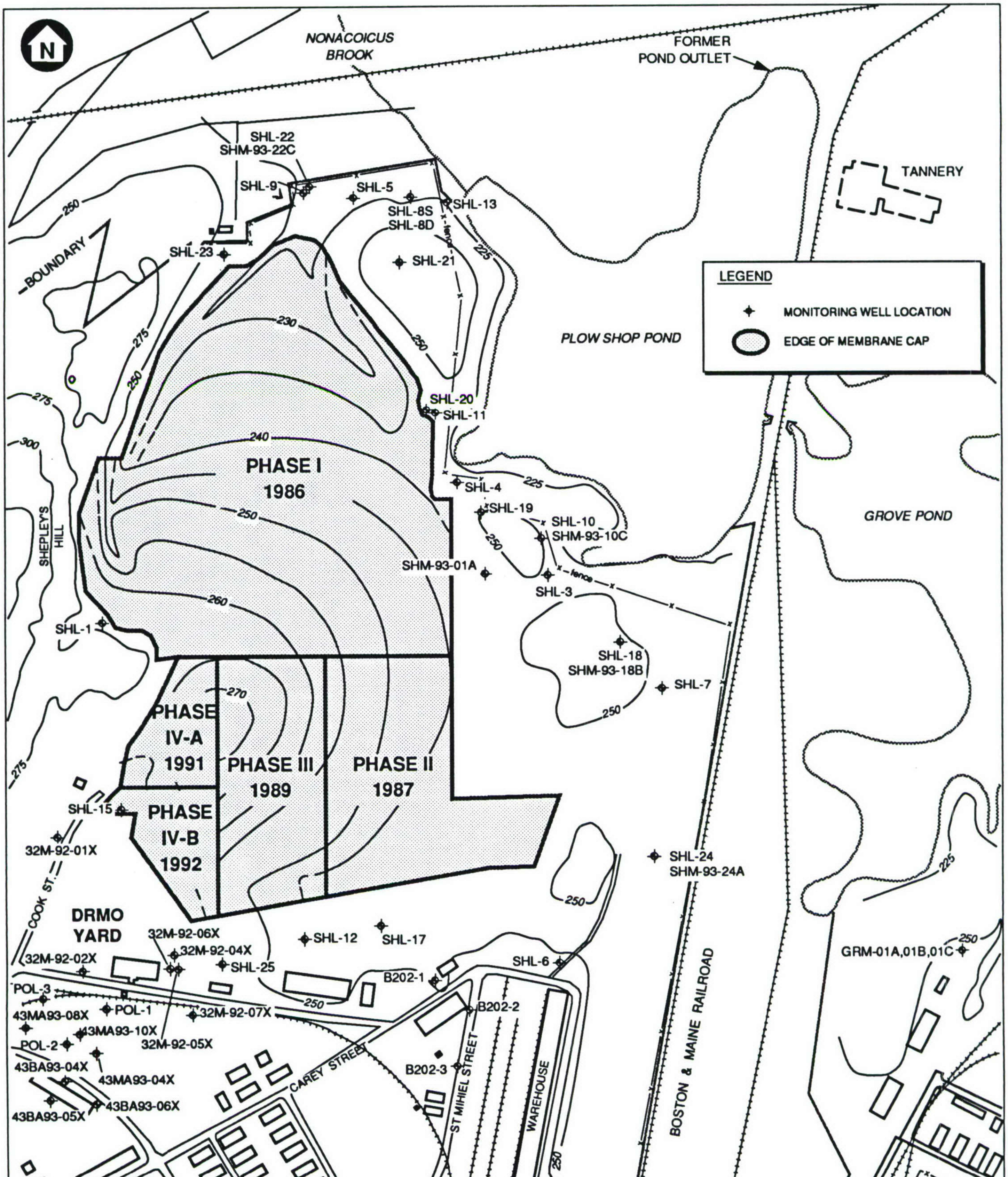

FIGURE 1-4
SHEPLEY'S HILL LANDFILL SITE MAP
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

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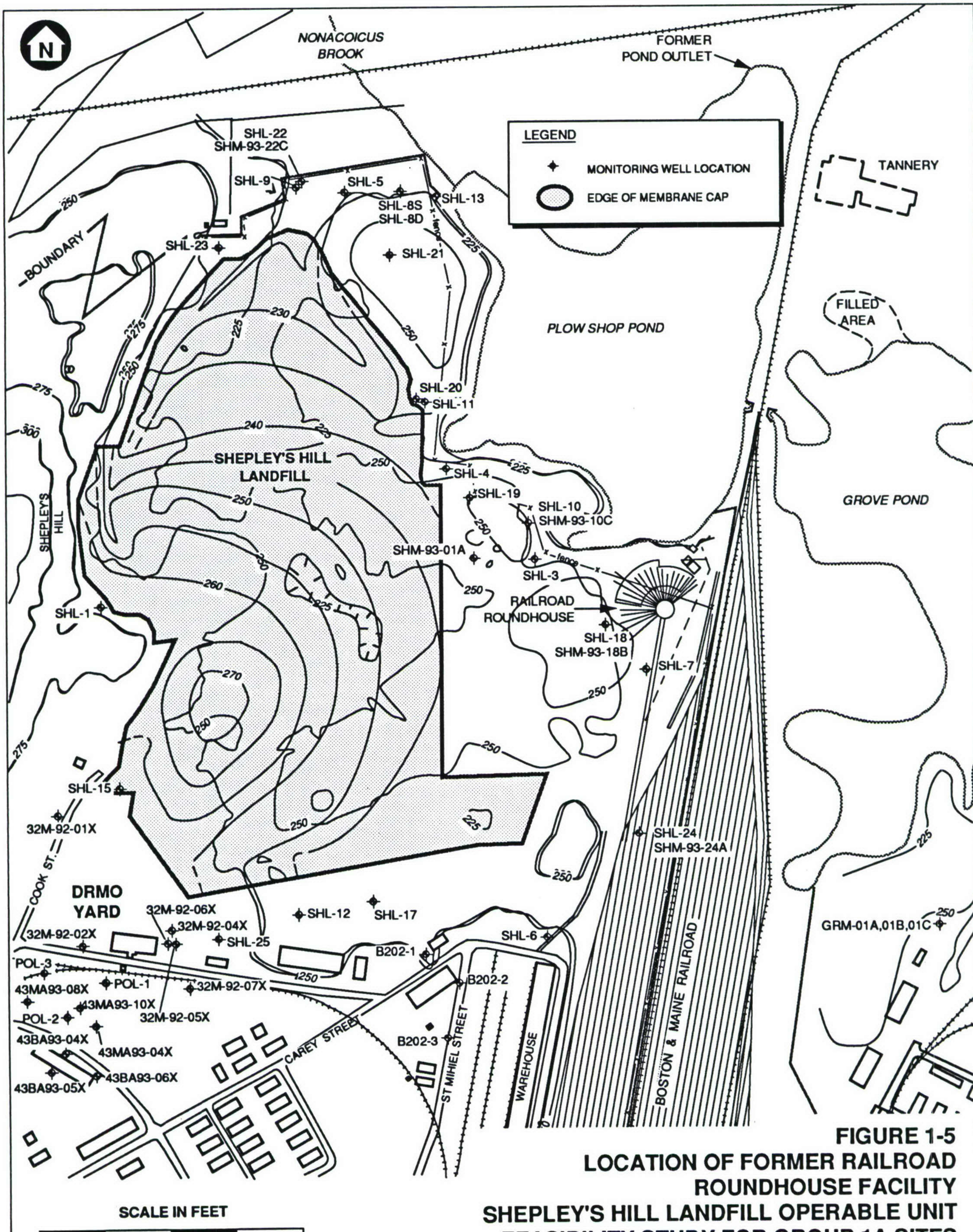

FIGURE 1-5
LOCATION OF FORMER RAILROAD ROUNDHOUSE FACILITY
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

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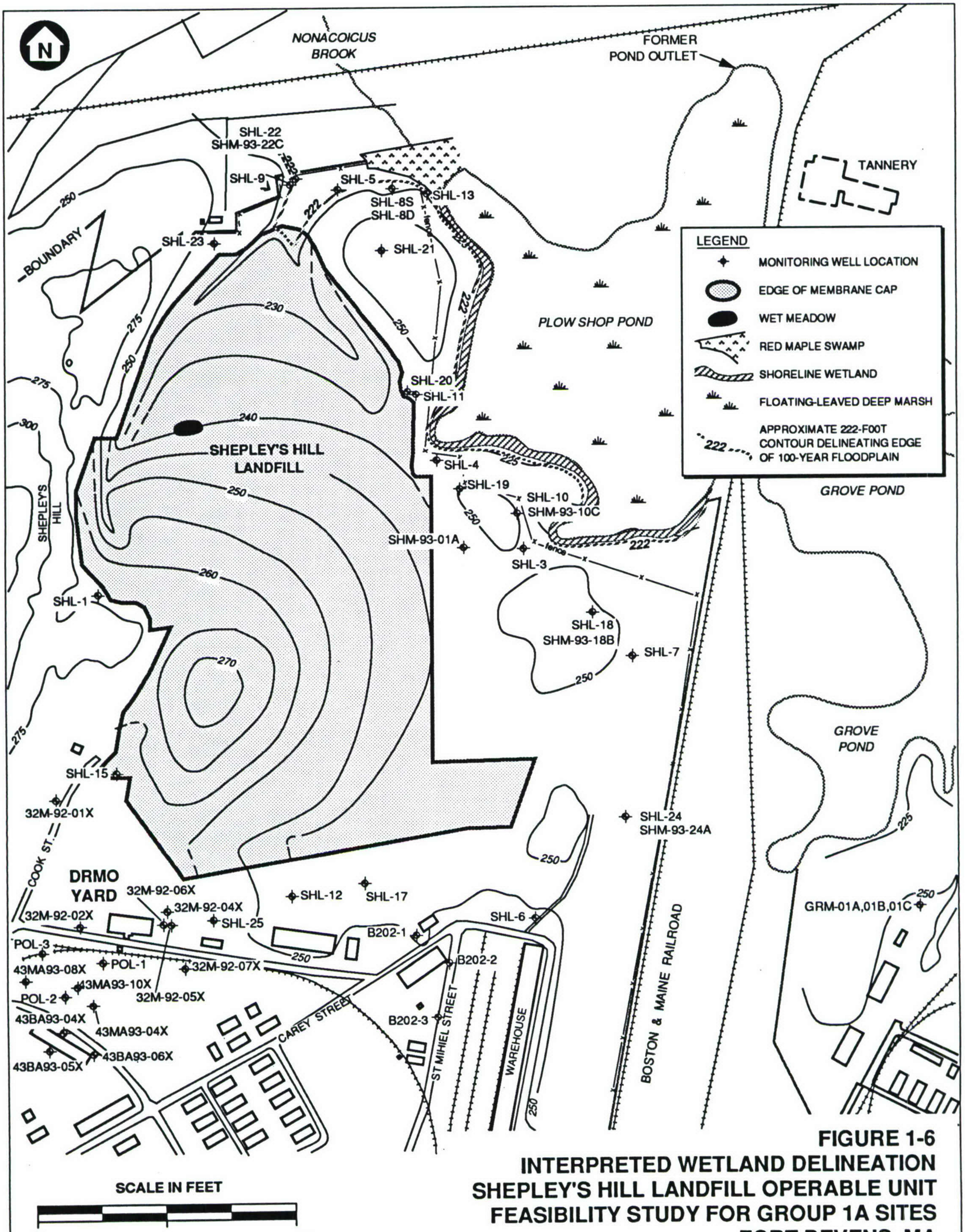

SOURCE: ECOLOGY AND ENVIRONMENT, INC., 1993.

FIGURE 1-6
INTERPRETED WETLAND DELINEATION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

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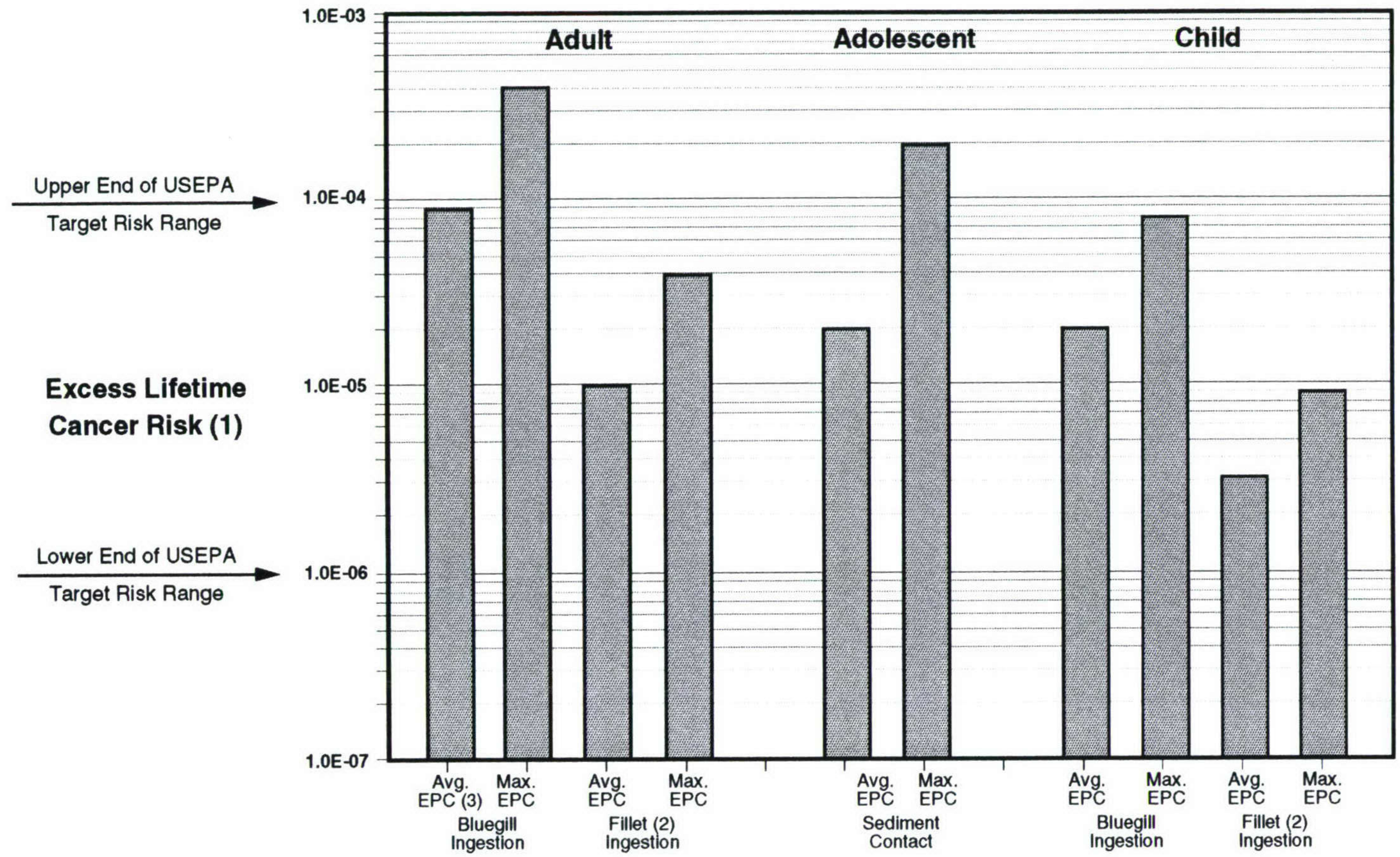

NOTE:

(1) Landfill-related COPCs account for between 96 and 100% of the total risk.

(2) Fillets include bullheads and largemouth bass.

(3) Avg. EPC = average exposure point concentration.
Max. EPC = maximum exposure point concentration.

FIGURE 1-7
SUMMARY OF CANCER RISK ESTIMATES
CURRENT LAND USE
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

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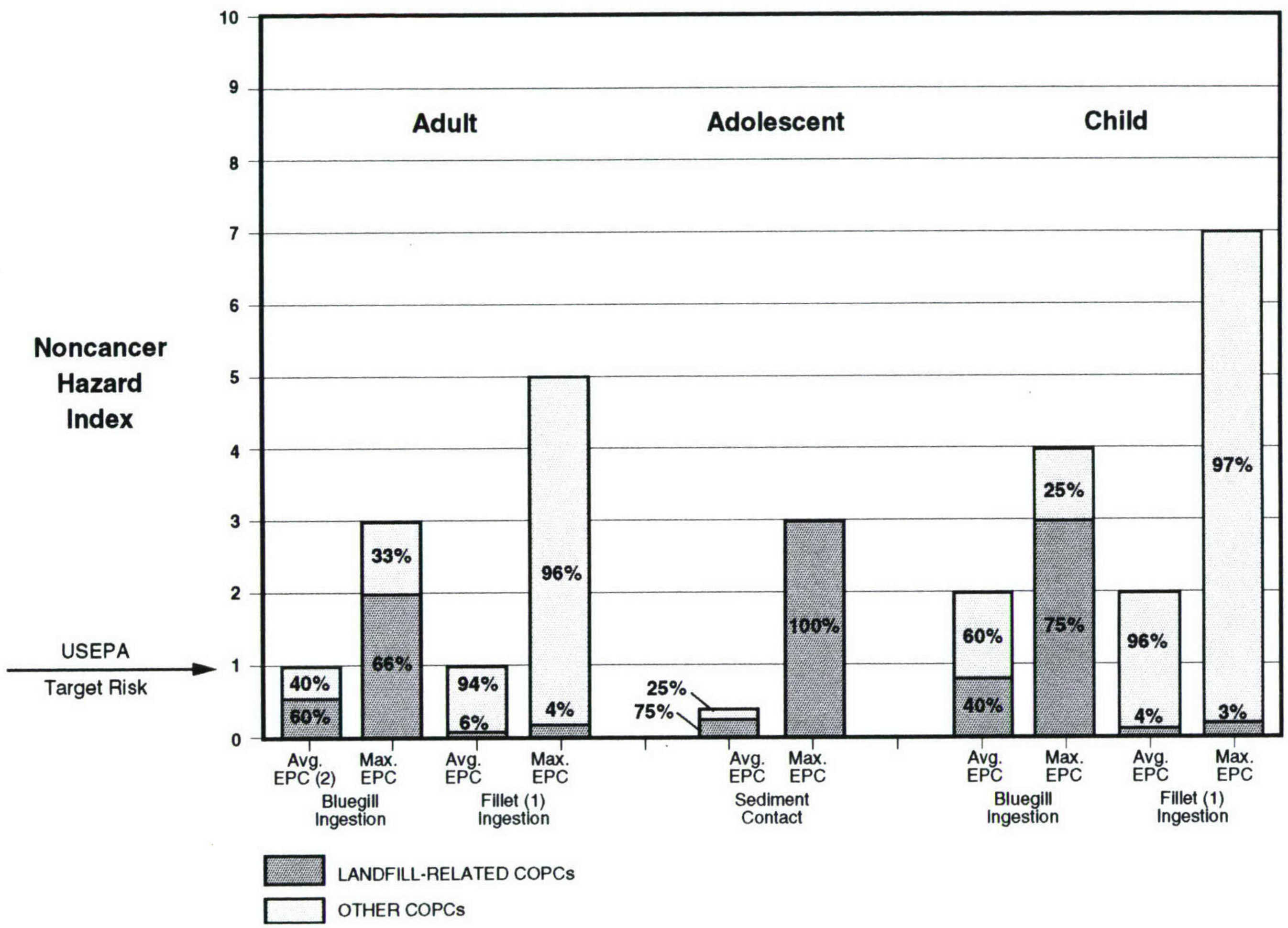

NOTE:

(1) Fillets include bullheads and largemouth bass.

(2) Avg. EPC = average exposure point concentration.
Max. EPC = maximum exposure point concentration.

FIGURE 1-8
SUMMARY OF NONCANCER RISK ESTIMATES
CURRENT LAND USE
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

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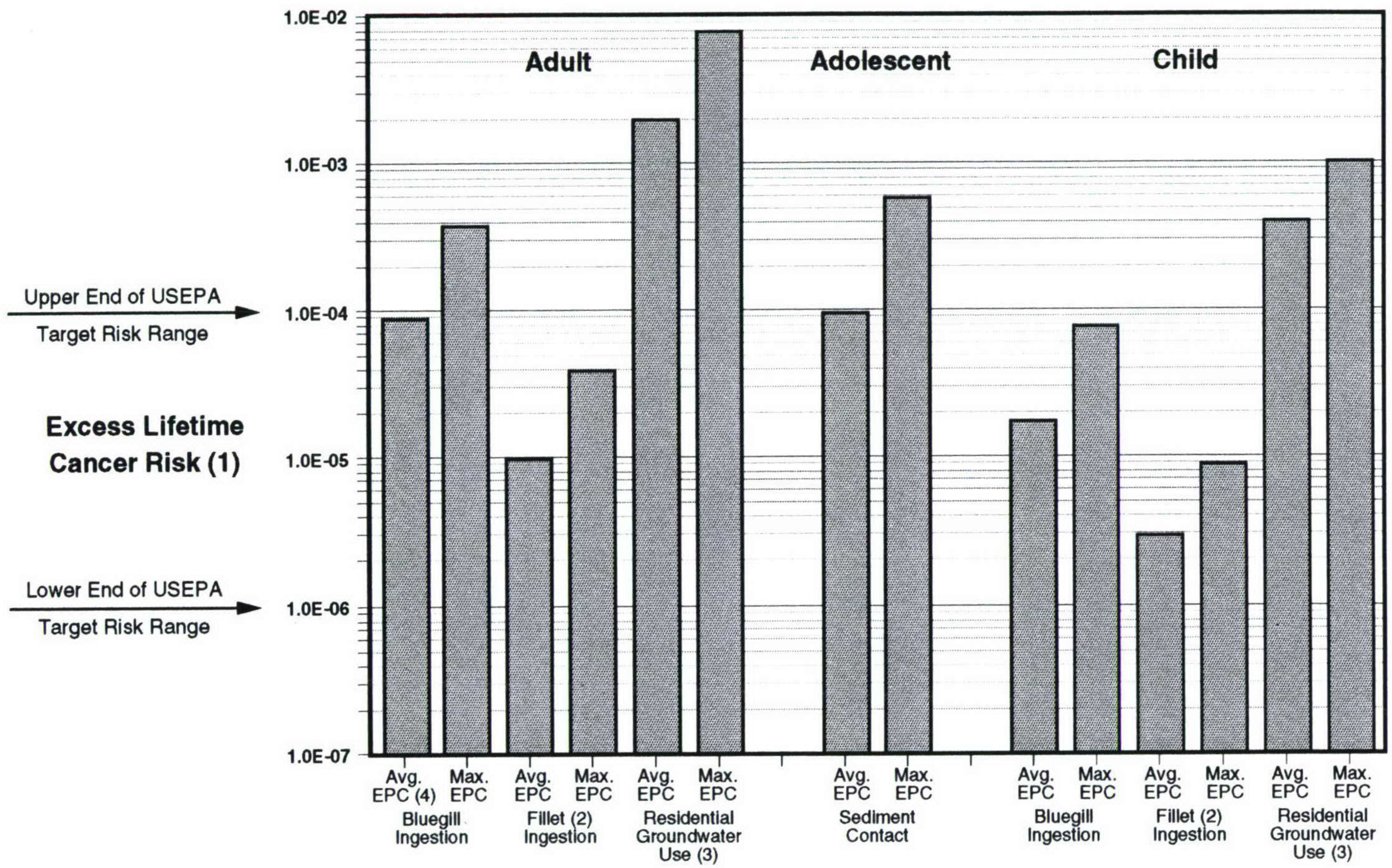

NOTE:

(1) Landfill-related COPCs account for between 96 and 100% of the total risk.

(2) Fillets include bullheads and largemouth bass.

(3) Groundwater estimates are based on unfiltered Supplemental RI samples.

(4) Avg. EPC = average exposure point concentration.
Max. EPC = maximum exposure point concentration.

FIGURE 1-9
SUMMARY OF CANCER RISK ESTIMATES
FUTURE LAND USE
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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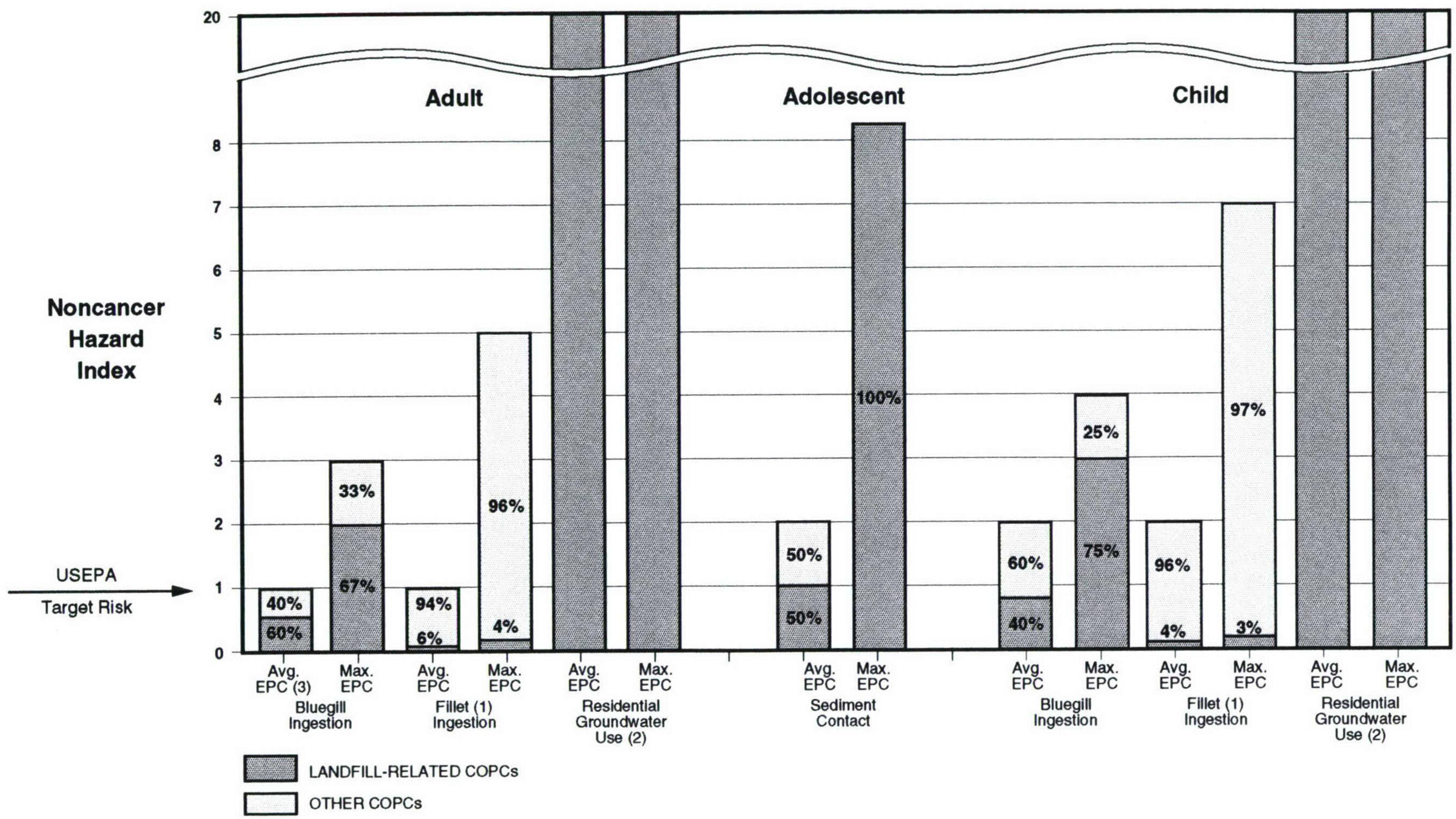

NOTE:

(1) Fillets include bullheads and largemouth bass.

(2) Groundwater estimates are based on unfiltered Supplemental RI samples.

(3) Avg. EPC = average exposure point concentration.
Max. EPC = maximum exposure point concentration.

FIGURE 1-10
SUMMARY OF NONCANCER RISK ESTIMATES
FUTURE LAND USE
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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TABLE 1-1
MONITORING WELL GROUPS AT SHEPLEY'S HILL LANDFILL

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

Southern Cross-gradient Wells	Well Group 1 Downgradient Wells	Northern Cross-gradient
SHL-6	SHL-3	SHL-8S
SHL-7	SHL-4	SHL-8D
SHL-12	SHL-5	SHL-13
SHL-17	SHL-9	SHL-21
SHL-24	SHL-10	
SHL-25	SHL-11	
SHM-93-24A	SHL-18	
	SHL-19	
	SHL-20	
	SHL-22	
	SHM-93-01A	
	SHM-93-10C	
	SHM-93-18B	
	SHM-93-22C	

Note:

Wells SHL-1, SHL-15, and SHL-23 are upgradient wells

TABLE 1-2
CHEMICALS EXCEEDING EVALUATION CRITERIA

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

CHEMICAL	GROUNDWATER WELL GROUP 1	PLOW SHOP POND SEDIMENT	PLOW SHOP POND SURFACE WATER H.H. AWQC	PLOW SHOP POND SURFACE WATER Eco. AWQC
VOLATILE ORGANIC COMPOUNDS				
Benzene	X			
Chloroethane	X			
1,1-dichloroethane	X			
1,2-dichloroethane	X			
1,2-dichloroethylenes	X			
1,2-dichloropropane	X			
Dichlorobenzenes	X			
Toluene	X			
SEMIVOLATILE ORGANIC COMPOUNDS				
Benzo(a)anthracene		X		
Chrysene		X		
Fluoranthene		X		
Naphthalene		X		
Phenanthrene		X		
Pyrene		X		
PESTICIDES/PCBs				
DDD		X		
DDE		X		
DDT		X		
INORGANICS				
Aluminum	X	n.a.		
Antimony	X	n.a.		
Arsenic	X	X*	X	
Barium	X	X*		
Beryllium		n.a.		
Calcium	X	n.a.		
Chromium	X	X		
Cobalt	X	n.a.		
Copper	X	X		X
Iron	X	X*	X	X
Lead	X	X		
Magnesium	X	n.a.		
Manganese	X	X*	X	
Mercury		X		
Nickel	X	X*	X	
Potassium	X	n.a.		
Selenium		n.a.		
Silver		n.a.		X
Sodium	X	n.a.		
Vanadium	X	n.a.		
Zinc	X	X		X

Notes:
There are no interpreted contaminants in surface soil at Shepley's Hill Landfill (E&E, 1993).
* = Arsenic, barium, iron, manganese, and nickel in sediment are considered landfill related.
H.H. AWQC = Ambient Water Quality Criteria for protection of human health.
Eco. AWQC = Ambient Water Quality Criteria for protection of aquatic life.
n.a. = Sediment evaluation criteria not available.

TABLE 1-3
CHEMICAL CONCENTRATIONS IN DOWNGRADIENT WELLS AT SHEPLEY'S HILL LANDFILL

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

CHEMICAL	UNFILTERED SAMPLES			FILTERED SAMPLES		
	FREQUENCY OF DETECTION	AVERAGE CONCENTRATION mg/L	MAXIMUM CONCENTRATION mg/L	FREQUENCY OF DETECTION	AVERAGE CONCENTRATION mg/L	MAXIMUM CONCENTRATION mg/L
1,1-Dichloroethane	4/14	0.00086	0.0044	NA	NA	NA
1,2-Dichloroethane	5/14	0.00097	0.0099	NA	NA	NA
1,2-Dichloropropane	1/14	0.00027	0.00052	NA	NA	NA
1,2-Dichloroethene (total)	6/14	0.0014	0.007	NA	NA	NA
Benzene	3/14	0.00051	0.0017	NA	NA	NA
Chloroethane	1/14	0.0013	0.0055	NA	NA	NA
Dichlorobenzenes	1/14	0.0054	0.011	NA	NA	NA
Toluene	1/14	0.0003	0.0006	NA	NA	NA
Aluminum	13/14	4.3	75.5	1/10	0.150	0.236
Antimony	2/14	0.0017	0.0033	1/10	0.002	0.003
Arsenic	12/14	0.10	0.39	6/10	0.071	0.27
Barium	13/14	0.048	0.35	10/10	0.030	0.117
Calcium	14/14	54	219	10/10	37	175
Chromium	5/14	0.009	0.115	0/10	NC	NC
Cobalt	1/14	0.014	0.0546	0/10	NC	NC
Copper	4/14	0.0086	0.0922	0/10	NC	NC

continued

TABLE 1-3
CHEMICAL CONCENTRATIONS IN DOWNGRADIENT WELLS AT SHEPLEY'S HILL LANDFILL

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

	Unfiltered Samples			Filtered Samples		
Chemical	Frequency of Detection	Average Concentration mg/L	Maximum Concentration mg/L	Frequency of Detection	Average Concentration mg/L	Maximum Concentration mg/L
Iron	14/14	17.6	97.4	7/10	14	91.6
Potassium	13/14	7.1	31.8	9/10	4.1	10.6
Magnesium	14/14	7.6	24	9/10	4.7	19.9
Manganese	14/14	2.4	9.65	10/10	1.8	9.54
Sodium	14/14	21	67.3	10/10	17	64.6
Nickel	1/14	0.023	0.177	0/10	NC	NC
Lead	10/14	0.0052	0.0668	0/10	NC	NC
Vanadium	3/14	0.094	0.0791	0/10	NC	NC
Zinc	3/14	0.029	0.22	1/10	0.011	0.025

Notes:

Averages based on one-half the sample quantitation limit for nondetected analytes.

NA = not analyzed
NC = not calculated

SECTION 2.0

2.0 ASSESSMENT OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Compliance with ARARs is one of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) criteria to be evaluated for each of the alternatives screened for detailed analysis in Section 5. CERCLA was passed by Congress and signed into law on December 11, 1980 (Public Law 96-510). This act was intended to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and cleanup of inactive waste disposal sites." The Superfund Amendments and Reauthorization Act, adopted on October 17, 1986 (Public Law 99-499), did not substantially alter the original structure of CERCLA, but provided extensive amendments to it.

In particular, § 121 of CERCLA specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or circumstances at a site. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

2.1 Terms and Definitions

The following is an explanation of the terms used throughout this ARARs discussion:

Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site" (*52 FR 32496*, August 27, 1987).

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar

to those encountered at the CERCLA site that their use is well suited to the particular site" (*52 FR 32496*).

Requirements under federal or state law may be either applicable or relevant and appropriate to CERCLA cleanup actions, but not both. However, requirements must be both relevant and appropriate for compliance to be necessary. In the case where both a federal and a state ARAR are available, or where two potential ARARs address the same issue, the more stringent regulation must be selected. However, CERCLA §121(d)(4) provides several ARAR waiver options that may be invoked, providing that the basic premise of protection of human health and the environment is not ignored. A waiver is available for state standards that have not been uniformly applied in similar circumstances across the state. In addition, CERCLA §121(d)(2)(C) forbids state standards that effectively prohibit land disposal of hazardous substances.

CERCLA on-site remedial response actions must only comply with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA §121(e)]. As noted in the ARARs guidance (USEPA, 1988a):

> The CERCLA program has its own set of administrative procedures which assure proper implementation of CERCLA. The application of additional or conflicting administrative requirements could result in delay or confusion.

Substantive requirements pertain directly to the actions or conditions at a site, while **administrative requirements** facilitate their implementation. In order to ensure that CERCLA response actions proceed as rapidly as possible, the USEPA has reaffirmed this position in the final National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (*55 FR 8756*, March 8, 1990). The NCP defines on-site as "the areal extent of contamination and all areas in very close proximity to the contamination necessary for implementation of the response action." The IAG provides additional guidance on the applicability of permitting requirements to response actions at Fort Devens (USEPA, 1991c). The USEPA recognizes that certain of the administrative requirements, such as consultation with state agencies, and reporting, are accomplished through the state involvement and public participation requirements of the NCP.

The Army's interpretation of the applicability of the Massachusetts Contingency Plan (MCP) to the Shepley's Hill Landfill Operable Unit parallels guidance provided by USEPA in comments dated February 28, 1994 on the Draft Proposed Plan and Final Feasibility Study for AOCs 44 and 52 at Fort Devens (USEPA, 1994). In its comments USEPA references the following sentences from the *CERCLA Compliance with Other Laws Manual* 310 CMR 40.0111(1)(a) provides:

> The CERCLA program has its own set of administrative procedures which assure proper implementation of CERCLA. The application of additional or conflicting administrative requirements could result in delay or confusion.

Further reference is made to the MCP at 310 CMR 40.0111 which contains a specific provision for deferring application of the MCP at CERCLA sites. 310 CMR 40.0111(1)(a) provides that response actions at CERCLA sites shall be deemed adequately regulated for purposes of compliance with the MCP, provided the MADEP concurs in the CERCLA record of decision.

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding, but may serve as useful guidance for remedial actions. These are not potential ARARs but are "to-be-considered" (TBC) guidance. These guidelines may be addressed as deemed appropriate.

ARARs are divided into the three categories listed below.

- **Location-specific ARARs** "set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (*53 FR 51394*). In determining the use of location-specific ARARs for selected remedial actions at CERCLA sites, one must investigate the jurisdictional prerequisites of each of the regulations. Basic definitions and exemptions, must be analyzed on a site-specific basis to confirm the correct application of the requirements.

- **Chemical-specific ARARs** are usually health- or risk-based standards that limit the concentration of a chemical found in or discharged to the environment. They govern the extent of site remediation by

providing either actual cleanup levels, or the basis for calculating such levels. For example, groundwater MCLs may provide the necessary cleanup goals for sites with contaminated groundwater. There are no direct chemical-specific ARARs for soils. Chemical-specific ARARs for the site may also be used to indicate acceptable levels of discharge in determining treatment and disposal requirements, and to assess the effectiveness of future remedial alternatives.

- **Action-specific ARARs** set controls or restrictions on particular kinds of activities related to the management of hazardous waste (53 *FR* 51437). Selection of a particular remedial action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. Action-specific ARARs are established under the Resource Conservation and Recovery Act (RCRA), the Clean Air Act, the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act, and other laws.

Many regulations can fall into more than one category. For example, many location-specific ARARs are also action-specific because they are triggered if remedial activities affect site features. Likewise, many chemical-specific ARARs are also location-specific.

The Occupational Safety and Health Administration (OSHA) has promulgated standards for protection of workers at hazardous waste operations at RCRA or CERCLA sites (29 CFR Part 1910). These regulations are designed to protect workers who would be exposed to hazardous waste. Federal construction activities involving no potential for hazardous substance exposure are covered by the OSHA standards found at 29 CFR Part 1926. USEPA requires compliance with the OSHA standards in the NCP (40 CFR 300.150), not through the ARAR process. Therefore, the OSHA standards are not considered as ARARs. They are discussed in the site-specific Health and Safety Plan.

Section 5 contains an alternative-specific discussion of ARARs.

2.2 Regulations Pertaining to Landfill Closure

This subsection discusses potential closure regulations for Shepley's Hill Landfill. Each of the identified regulations includes requirements for installing a landfill cover as part of landfill closure. All of the discussed regulations contain performance standards for cover systems, and the Massachusetts Solid Waste Management regulations and the USEPA Municipal Solid Waste Landfill (MSWLF) regulations contain specific design and component standards. In addition, the regulations contain requirements for post-closure care such as facility maintenance and groundwater and landfill gas monitoring. The identification of regulations relating to landfill closure is particularly important because of the high cost associated with constructing and installing a landfill cover. Other regulations are discussed in Section 5.

Landfill closure regulations appropriate for consideration relative to Shepley's Hill Landfill include the following:

- Massachusetts Solid Waste Management Regulations at 310 CMR 19.000
- USEPA Regulations for Owners and Operators of Permitted Hazardous Waste Facilities at 40 CFR Part 264
- USEPA Criteria for Municipal Solid Waste Landfills at 40 CFR Part 258
- Massachusetts Hazardous Waste Management Rules at 310 CMR 30.000

Massachusetts Solid Waste Management Regulations at 310 CMR 19.000 regulate the storage, transfer, processing, treatment, disposal, use, and reuse of solid waste in Massachusetts. The regulations apply to all solid waste management facilities, including landfills. They are considered applicable to the closure of Shepley's Hill Landfill. The regulations were adopted effective July 1, 1990 and contain provisions for facilities already in existence at that time. Specifically, 310 CMR 19.021 states that after July 1, 1990 and until July 1, 1992 existing facilities may continue to operate in accordance with a approved plan issued by the MADEP on or before December 17, 1987 pursuant to Massachusetts Regulations for The

Disposal of Solid Wastes by Sanitary Landfill, April 1971, 310 CMR 19.00). The requirements for closure at Shepley's Hill Landfill are contained in the May 30, 1985 plan approval letter and are consistent with 310 CMR 19.00. The approved closure plan included:

- grading the landfill surface to a minimum 2 percent slope in non-operational areas of the landfill and 3 percent in operational areas

- removing waste from selected areas within 100 feet of the 100-year floodplain

- installing a gas venting system

- installing an impermeable 30-mil PVC membrane cap and covering the cap with sand, gravel, and loam, and seeding to provide cover vegetation and prevent erosion

- implementing a groundwater monitoring program

The Solid Waste Management Regulations (319 CMR 19.000) that replaced the sanitary landfill regulations of 1971 provide general performance standards and general design standards for cover systems as well as technical standards for final cover system components. These standards are summarized below.

General Performance Standards

- minimize the percolation of water through the final cover system into the landfill to the greatest extent practicable

- promote proper drainage of precipitation

- minimize erosion of the cover

- facilitate the venting and control of landfill gas

- ensure isolation of landfill wastes from the environment

- accommodate settling and subsidence of the landfill such that the above performance standards will continue to be met

General Design Standards

- minimum top slope of 5 percent, maximum side slope of 3 horizontal to 1 vertical
- be constructed of materials compatible with expected landfill gases
- be constructed to minimize erosion
- be constructed to protect the low permeability layer from adverse effects of frost
- be constructed to maintain slope stability

Component Standards (from bottom to top)

- Landfill gas venting layer: Minimum thickness of six inches. Hydraulic conductivity of at least $1x10^{-3}$ cm/sec
- Low permeability layer: Eighteen inches of natural or amended soil with a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec or a flexible membrane liner
- Drainage layer: A minimum of six inches of soil with a hydraulic conductivity of at least $1x10^{-3}$ cm/sec or an approved geosynthetic
- Vegetative layer: At least 12 inches of soil capable of supporting the selected vegetation
- There shall be at least 18 inches of soil material in the drainage and vegetative support layers above the low permeability layer

The adequacy of landfill closure measures undertaken pursuant to 310 CMR 19.000 is assessed by evaluation of environmental monitoring data collected during the post-closure period. If monitoring data exceed established criteria or indicate

potential adverse impacts to public health, safety, or the environment, corrective action may be required.

USEPA regulations at 40 CFR Part 264 for owners and operators of permitted hazardous waste facilities were promulgated pursuant to RCRA Subtitle C. Subpart N (40 CFR 264.300 through 264.317) pertains specifically to hazardous waste landfills and contains requirements for closure and post-closure care. RCRA Subtitle C requirements for the treatment, storage, and disposal of hazardous wastes are applicable for a Superfund remedial action if the following conditions are met:

The waste is a RCRA hazardous waste, and either:

1) The waste was initially treated, stored, or disposed of after November 19, 1980, the effective date of Subtitle C regulations, or

2) The activity at the CERCLA site constitutes treatment, storage, or disposal.

At Shepley's Hill Landfill wastes were disposed of through June 1992; however, they have not been identified as hazardous wastes. In addition, the grading of wastes within Shepley's Hill Landfill during capping activities does not constitute treatment, storage, or disposal. Therefore, Subtitle C regulations are not considered applicable. However, Subtitle C is considered relevant and appropriate to the closure of Shepley's Hill Landfill. If Subtitle C were considered applicable, USEPA could require installation of a Subtitle C cap on the landfill. Because Subtitle C is considered relevant and appropriate, USEPA can allow the current cap to remain in place as part of a hybrid closure that includes long-term cover management, groundwater monitoring, and institutional controls USEPA, 1991b).

RCRA regulations at 40 CFR 264.310 state that at final closure of a hazardous waste landfill the owner or operator must cover the landfill with a final cover designed and constructed to meet the following five performance criteria:

1) provide long-term minimization of migration of liquids through the closed landfill;

2) function with minimum maintenance;

3) promote drainage and minimize erosion or abrasion of the cover;

4) accommodate settling and subsidence so that the cover's integrity is maintained; and

5) have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

The USEPA publication *Design and Construction of RCRA/CERCLA Final Covers* recommends the following design for a Subtitle C cover (USEPA, 1991b):

1) A Low Hydraulic Conductivity Geomembrane/Soil Layer. A 60-cm (24-inch) layer of compacted natural or amended soil with a hydraulic conductivity of $1x10^{-7}$ cm/sec in intimate contact with a minimum 0.5-mm (20-mil) geomembrane liner.

2) A Drainage Layer. A minimum 30-cm (12-inch) soil layer having a minimum hydraulic conductivity of $1x10^{-2}$ cm/sec, or a layer of geosynthetic material having the same characteristics.

3) A Top, Vegetative/Soil Layer. A top layer with vegetation (or an armored top surface) and a minimum of 60 cm (24-inch) of soil graded at a slope between 3 and 5 percent.

Groundwater monitoring is used to assess whether the facility closure achieves compliance with established groundwater protection standards, and whether corrective action is to be implemented to meet standards and protect human health and the environment.

USEPA regulations at 40 CFR Part 258 establish minimum national criteria under RCRA for MSWLF units. However, because Shepley's Hill Landfill is already regulated under Massachusetts regulations (i.e., 310 CMR 19.000), 40 CFR 258 is considered relevant and appropriate, but not applicable. The USEPA regulations specify at 40 CFR 258.1(d)(4) that MSWLF units that received waste after October 9, 1991, but stopped receiving waste before April 9, 1994 and do not meet other specific criteria, are exempt from all the requirements of 40 CFR Part

258 except the final cover requirements of 40 CFR 258.60(a). The final cover system must be designed and constructed to:

- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than $1x10^{-5}$ cm/sec, whichever is less
- Minimize infiltration through the closed MSWLF by use of an infiltration layer that contains a minimum of 18-inches of earthen material
- Minimize erosion of the final cover by use of an erosion control layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth

Massachusetts Hazardous Waste Management Regulations at 310 CMR 30.000 regulate the generation, storage, collection, transport, treatment, disposal, use, reuse, and recycling of hazardous materials in Massachusetts. Because wastes at Shepley's Hill Landfill have not been identified as hazardous, 310 CMR 30.000 is not considered applicable. It is considered relevant and appropriate, however.

The regulations specify that at final closure a landfill will be covered with a final cover designed and constructed to:

- Provide long term minimization of migration of liquids through the closed landfill
- Function with minimum maintenance
- Promote drainage and minimize erosion and abrasion of the cover
- Accommodate settling and subsidence so that cover integrity is maintained
- Have a permeability less than or equal to the permeability of the bottom liner system

Groundwater monitoring conducted as part of stipulated post-closure activities is used to assess if regulated hazardous waste management units are in compliance with established groundwater standards and whether corrective action is to be implemented to achieve compliance.

In conclusion, Massachusetts Solid Waste Management Regulations at 310 CMR 19.000 are considered applicable at the Shepley's Hill landfill Operable Unit, while the capping requirements of Massachusetts Hazardous Waste Management Regulations, and RCRA Subtitle C, and RCRA Subtitle D regulations are considered relevant and appropriate.

SECTION 3.0

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Response and remedial action objectives form the basis for identifying remedial technologies and developing remedial alternatives. This section identifies response and remedial action objectives, and potential general response actions to meet those objectives. Remedial technologies considered implementable, and which also address the remedial action objectives and general response actions, are identified. Candidate remedial technologies are then screened based on their applicability to site and waste characteristics. The purpose of the screening is to produce an inventory of suitable technologies that can be assembled into remedial alternatives capable of mitigating actual or potential risks at the Shepley's Hill Landfill Operable Unit.

The Shepley's Hill Landfill Operable Unit includes all media and contamination of concern at Shepley's Hill Landfill except surface water and sediment in Plow Shop Pond. Technologies and alternatives to remediate sediment contamination in Plow Shop Pond will be evaluated in a separate document for the Plow Shop Pond Operable Unit.

3.1 IDENTIFICATION OF RESPONSE OBJECTIVES

Response objectives are site-specific, qualitative cleanup objectives based on the nature and extent of contamination, the resources currently or potentially threatened, and the potential for human and environmental exposure. For the Shepley's Hill Landfill Operable Unit, response objectives were formulated based on environmental concerns defined in the human health and ecological risk assessments. Response objectives are used to develop remedial action objectives and appropriate remedial alternatives.

Based on the human health and ecological risk assessments in the RI and RI Addendum Reports, the following response objectives were identified for the Shepley's Hill Landfill Operable Unit:

- Protect potential residential receptors from exposure to contaminated groundwater migrating from the landfill having chemicals in excess of MCLs and health-based ARARs.

- Prevent contaminated landfill groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations.

Response objectives were not identified for surface soil, landfill gas, or leachate. The risk assessments did not identify potential risks from exposure to surface soil, and ambient air monitoring during the RI did not identify airborne contaminants. Liquid leachate was not identified during either RI or supplemental RI activities.

3.2 Preliminary Remediation Goals

Preliminary Remediation Goals (PRGs) are numerical goals for site cleanup that are intended to be protective and to comply with ARARs. PRGs are based both on risk assessment and on ARARs. PRGs for the Shepley's Hill Landfill Operable Unit were developed following the USEPA guidance document entitled, *Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*, Interim, December 1991 (RAGS Part B) (USEPA, 1991d) and OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (USEPA, 1991e). The first step in developing human health PRGs is to identify those environmental media that in the baseline risk assessment present either a cumulative current or future cancer risk greater than $1x10^{-4}$ or a cumulative noncarcinogenic HI greater than 1, based on RME assumptions. The next step is to identify COPCs within the medium that present cancer risks greater than $1x10^{-6}$ or an HQ greater than 1. Following identification of media of concern and COPCs, PRGs are developed and refined by considering the following:

- ARARs
- exposure factors
- technical factors, and
- uncertainty factors

Because groundwater was the only medium at the Shepley's Hill Landfill Operable Unit with potential risks that exceeded USEPA criteria, only the groundwater exposure pathway in the baseline human health risk assessment was reviewed for the development of PRGs. Exposure to groundwater represents a potential exposure pathway under assumptions of future land use. Groundwater

as an exposure medium was not evaluated in the baseline risk assessment under conditions of current land use. Tables 3-1 and 3-2 have been extracted from the baseline risk assessment and summarize the risk estimates associated with Shepley's Hill Landfill, including potential future residential groundwater use.

The risk estimates in Tables 3-1 and 3-2 for residential groundwater use have been modified since the baseline risk assessment (ABB-ES, 1993b). This is because the spreadsheets (Appendix K of ABB-ES, 1993b) used to calculate the intake from ingestion of groundwater inadvertently included the factor "ET" for shower exposure time in the numerator of the ingestion intake equation for groundwater. This factor has been removed, and Tables 3-1 and 3-2 contain corrected values.

As seen in Tables 3-1 and 3-2, the risk estimates associated with residential groundwater use exceed the USEPA risk management criteria of a $1x10^{-4}$ cancer risk and a HI of one. Chemicals of concern in the groundwater whose risks exceed a $1x10^{-6}$ cancer risk or a HI of one include arsenic, 1,2-dichloroethane, dichlorobenzenes, and manganese. In addition, the baseline risk assessment identified the following chemicals as exceeding their respective drinking water standard or guideline: aluminum, chromium, iron, lead, nickel, and sodium.

Table 3-3 contains federal and Commonwealth drinking water standards and guidelines for these chemicals of concern. It also lists the basewide background concentrations of inorganics in unfiltered groundwater samples at Fort Devens and the average and maximum exposure point concentrations (EPCs) in Well Group 1 groundwater. The estimation of background concentrations is discussed in Section 4 of the RI Addendum Report (ABB-ES, 1993b). The EPCs were reported in the baseline risk assessment (ABB-ES, 1993b). PRGs are proposed as either the lowest drinking water standard or guideline, or as the background concentration, whichever is highest. As seen in Table 3-3, ARARs-based PRGs are proposed for arsenic, chromium, dichlorobenzenes, 1,2-dichloroethane, lead, nickel, and sodium. PRGs are proposed at background concentrations for aluminum, iron, and manganese. Risk-based PRGs were not developed for the Shepley's Hill Landfill Operable Unit.

3.3 Remedial Action Objectives

Remedial action objectives are medium- or operable unit-specific, quantitative goals defining the extent of cleanup required to achieve response objectives. They specify contaminants of concern, exposure routes and receptors, and PRGs. In the case of groundwater, they also include a restoration time frame. Remedial action objectives are used as the framework for developing remedial alternatives. Table 3-4 lists remedial action objectives for the Shepley's Hill Landfill Operable Unit. The remedial action objectives are formulated to achieve the overall goal of USEPA of protecting human health and the environment.

3.4 General Response Actions

General response actions describe categories of remedial actions that may be employed to satisfy remedial action objectives. General response actions provide the basis for identifying specific remedial technologies.

Applicable general response actions are listed in Tables 3-5 and 3-6. General response actions for groundwater at the Shepley's Hill Landfill Operable Unit include the following: No Action, Limited Action, Containment, Collection, Treatment, and Discharge. These general response actions are in accordance with recommendations made in USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988b).

3.5 Technology Identification

Categories of remedial technologies and specific process options were identified based on a review of literature, vendor information, performance data, and experience in developing other FSs under CERCLA. Of these process options, 28 were selected as being potentially applicable to attaining the remedial response objectives. Applicable remedial technologies and associated process options are identified for each of the six possible general response actions (i.e., No Action, Limited Action, Containment, Collection, Treatment, and Discharge) as shown in Table 3-5. Table 3-6 provides descriptions for the groundwater process options.

3.6 TECHNOLOGY SCREENING

The technology screening process reduces the number of potentially applicable technologies and process options by evaluating factors that may influence process option effectiveness and implementability. This overall screening is consistent with the guidance for conducting FSs under CERCLA (USEPA, 1988b).

The screening process assesses each technology or process option for its probable effectiveness and implementability with regard to site-specific conditions, known and suspected contaminants, and affected environmental media. The effectiveness evaluation focuses on: (1) whether the technology is capable of handling the estimated areas or volumes of media and meeting the contaminant reduction goals identified in the remedial action objectives; (2) the effectiveness of the technology in protecting human health during the construction and implementation phase; and (3) how proven and reliable the technology is with respect to the contaminants and conditions at the site. Implementability encompasses both the technical and institutional feasibility of implementing a technology. Effectiveness and implementability are incorporated into two screening criteria: waste- and site-limiting characteristics.

Waste-limiting characteristics largely establish the effectiveness and performance of a technology; site-limiting characteristics affect implementability of a technology. Waste-limiting characteristics consider the suitability of a technology based on contaminant types, individual compound properties (e.g., volatility, solubility, specific gravity, adsorption potential, and biodegradability), and interactions that may occur between mixtures of compounds (e.g., reactions and increased solubility). Site-limiting characteristics consider the effect of site-specific physical features, including topography, buildings, underground utilities, available space, and proximity to sensitive operations, on the implementability of a technology. Technology screening based on waste- and site-limiting characteristics serves a two-fold purpose of screening out technologies whose applicability is limited by site-specific waste or site considerations, while retaining as many potentially applicable technologies as possible.

Table 3-7 summarizes the technology screening phase for the Shepley's Hill Landfill Operable Unit at Fort Devens. Technologies and process options judged ineffective or not implementable were eliminated from further consideration.

Table 3-8 summarizes the groundwater technologies retained for further consideration. The technologies retained following screening represent an inventory of technologies considered most suitable for groundwater at the Shepley's Hill Landfill Operable Unit. Technologies retained in this section may be used to develop remedial alternatives. Treatability studies may be required prior to final technology selection to confirm the effectiveness of a given technology.

TABLE 3-1

SUMMARY OF CANCER RISK ESTIMATES[1]

FUTURE LAND USE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT

FEASIBILITY STUDY FOR GROUP 1A SITES

FORT DEVENS, MA

EXPOSURE SCENARIO	ADULT		ADOLESCENT		CHILD		RISK CONTRIBUTIONS (BY CHEMICAL)
	AVERAGE EPC	MAXIMUM EPC	AVERAGE EPC	MAXIMUM EPC	AVERAGE EPC	MAXIMUM EPC	
Ingestion of Bluegills							
Landfill-related COPCs	9E-05	4E-04	NA	NA	2E-05	8E-05	Arsenic (99 %)
Total Risk- All COPCs	9E-05	4E-04	NA	NA	2E-05	8E-05	
Ingestion of Fillets (bullhead and bass)							
Landfill-related COPCs	1E-05	4E-05	NA	NA	3E-06	9E-06	Arsenic (96 %)
Total Risk- All COPCs	1E-05	4E-05	NA	NA	3E-06	1E-05	
Sediment Contact							
Landfill-related COPCs	NA	NA	9E-05	6E-04	NA	NA	Arsenic (96 %)
Total Risk- All COPCs	NA	NA	9E-05	6E-04	NA	NA	
Residential Groundwater Use (Well Group 1)							
Unfiltered	2E-03	8E-03	NA	NA	4E-04	1E-03	Arsenic (99 %)[2]
Filtered	1E-03	6E-03	NA	NA	3E-04	1E-03	Arsenic (100 %)
Total Risk[3]							
Unfiltered	2E-03	9E-03	NA	NA	4E-04	1E-03	
Filtered	1E-03	7E-03	NA	NA	3E-04	1E-03	

Notes:

[1]As reported in the Fort Devens Group 1A Sites Final Remedial Investigation Addendum Report (December 1993).

[2]Two additional COPCs, 1,2-dichloroethane ($1x10^{-5}$) and dichlorobenzenes ($6x10^{-6}$), present cancer risks above the USEPA point of departure of $1x10^{-6}$, but account for less than 1% of the total risk.

[3]Total risk is calculated for adults who consume COPCs in fillets, contact sediment, and use the groundwater from Well Group 1 for domestic purposes. Total risk is calculated for children who consume fillets and use the groundwater from Well Group 1 for domestic purposes.

EPC= Exposure Point Concentration

NA= Not Applicable

Note: Shaded risk estimates represent updated values, different from those reported in the Final RI Addendum Report (December 1993); an error existed in the December 1993 risk spreadsheets and the shaded risk estimates are corrected values.

TABLE 3-2

SUMMARY OF NONCANCER RISK ESTIMATES[1]

FUTURE LAND USE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT

FEASIBILITY STUDY FOR GROUP 1A SITES

FORT DEVENS, MA

EXPOSURE SCENARIO	ADULT		ADOLESCENT		CHILD		RISK CONTRIBUTIONS[2]
	AVERAGE EPC	MAXIMUM EPC	AVERAGE EPC	MAXIMUM EPC	AVERAGE EPC	MAXIMUM EPC	(BY CHEMICAL)
Ingestion of Bluegills							
Landfill-related COPCs	0.6	2	NA	NA	0.8	3	
Total Risk- All COPCs	1	3	NA	NA	2	4	Arsenic (0.5,2; skin)
Ingestion of Fillets (bullhead and bass)							
Landfill-related COPCs	0.06	0.2	NA	NA	0.08	0.2	
Total Risk- All COPCs	1	5	NA	NA	2	7	Mercury (2,7; kidney)
Sediment Contact							
Landfill-related COPCs	NA	NA	1	10	NA	NA	
Total Risk- All COPCs	NA	NA	2	10	NA	NA	Arsenic (1,8), Manganese (0.06,1; CNS effect
Residential Groundwater Use (Well Group 1)							
Unfiltered	20	90	NA	NA	20	100	Arsenic (9, 36), Manganese (12, 55)[3]
Filtered	20	80	NA	NA	20	90	Arsenic (7,25), Manganese (10,55)
Total Risk[4]							
Landfill-related COPCs:							
Unfiltered	20	90	NA	NA	20	100	
Filtered	20	80	NA	NA	20	90	
All COPCs:							
Unfiltered	21	95	NA	NA	22	107	
Filtered	21	85	NA	NA	22	97	

Notes:

[1]As reported in the Fort Devens Group 1A Sites Final Remedial Investigation Addendum Report (December 1993).

[2]Hazard quotients for individual chemicals shown in parentheses, at average and maximum EPCs, respectively, for receptor showing greatest risk. Toxicity endpoint of dose-response value also shown in parentheses.

[3]At maximum concentrations, the hazard quotients for six other COPCs were 0.1 or greater: benzene (0.4), vanadium (0.3), antimony (0.3), barium (0.1), chromium (0.6), and nickel (0.3).

[4]Total risk is calculated for adults and children who consume COPCs in fillets and use the groundwater from Well Group 1 for domestic purposes.

EPC= Exposure Point Concentration

NA= Not Applicable

Note: Shaded risk estimates represent updated values, different from those reported in the Final RI Addendum Report (December 1993); an error existed in the December 1993 risk spreadsheets and the shaded risk estimates are corrected values.

TABLE 3-3
PROPOSED PRELIMINARY REMEDIATION GOALS
FOR GROUNDWATER

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

CHEMICAL OF CONCERN	WELL GROUP 1 AVERAGE EPC (µg/L)		WELL GROUP 1 MAXIMUM EPC (µg/L)		BACKGROUND CONCENTRATION (µg/L)	DRINKING WATER STANDARDS AND GUIDELINES							PROPOSED PRG (µg/L)
	UNFILTERED	FILTERED	UNFILTERED	FILTERED		MCL (µg/L)	SMCL (µg/L)	MCLG (µg/L)	HA (µg/L)	MMCL (µg/L)	SMCL (µg/L)	ORSG (µg/L)	
Aluminum	4,259	NA	75,500	236	6,870	–	50 – 200	–	–	–	50 – 200	–	6,870
Arsenic	101	71	390	270	10.5	50	–	–	–	50	–	–	50
Chromium	9	ND	115	ND	14.7	100	–	100	100	100	–	–	100
Dichlorobenzenes	5.4	NA	11	NA	NA	75[3]	–	75	75	5[3]	–	–	5
1,2-Dichloroethane	0.97	NA	9.9	NA	NA	5	–	0	–	5	–	–	5
Iron	17,608	14,427	97,400	91,600	9,100	–	300	–	–	–	300	–	9,100
Lead	5.2	NA	66.8	1.52	4.25	15[4]	–	0	–	15	–	–	15
Manganese	2045	1812	9650	9540	291	–	50	–	–	–	50	–	291
Nickel	22.9	ND	177	ND	34.3	100	–	100	100	100	–	–	100
Sodium	20,749	16,934	67,300	64,600	10,800	–	–	–	20,000	–	–	28,000	20,000

Notes:
[1] "Drinking Water Regulations and Health Advisories", December 1993, USEPA Office of Water
[2] "Drinking Water Standards & Guidelines for Chemicals in Massachusetts Drinking Waters", Spring 1993, Massachusetts Department of Environmental Protection
[3] Value for p-dichlorobenzene, the lowest of the three isomers. The MCL & MMCL for O-Dichlorobenzene are both 600 µg/L.
[4] Action level[1]
EPC = Exposure Point Concentration
ND = Not detected
NA = Not appropriate
MCL = Maximum Contaminant Level[1]
SMCL = Secondary MCL[1]
MCLG = Maximum Contaminant Level Goal[1]
HA = Health Advisory[1]
MMCL = Massachusetts MCL[2]
ORSG = Massachusetts Department of Environmental Protection Office of Research and Standards Guideline[2]

TABLE 3-4
REMEDIAL ACTION OBJECTIVES FOR SHEPLEY'S HILL LANDFILL

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

SHEPLEY'S HILL LANDFILL GROUNDWATER	
•	Prevent potential residential exposure to groundwater containing chemicals in excess of the following site-specific PRGs: dichlorobenzenes (5 μg/L)*, 1,2-dichloroethane (5 μg/L), aluminum (6,870 μg/L), arsenic (50 μg/L), chromium (100 μg/L), iron (9,100 μg/L), lead (15 μg/L), manganese (291 μg/L), nickel (100 μg/L), and sodium (20,000 μg/L).
•	Prevent off-site migration of groundwater containing chemicals in excess of the above concentrations.
•	Prevent contaminated landfill groundwater from contributing to arsenic contamination of Plow Shop Pond sediments in excess of health- and risk-based ARARs.
•	Meet location-specific and action-specific ARARs.

Notes:

*The value of 5 μg/L pertains to 1,4-dichlorobenzene. The PRG for 1,2-dichlorobenzene would be 600 μg/L.

TABLE 3-5
POTENTIAL REMEDIAL TECHNOLOGIES FOR GROUNDWATER

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION
NO ACTION	None	Not Applicable
MINIMAL ACTION	Institutional Controls	Zoning Restrictions
		Deed Restrictions
	Environmental Monitoring	Groundwater Monitoring
	Landfill Cap Maintenance	As Applicable
CONTAINMENT	Capping	Composite Barrier
	Hydraulic Barriers	Slurry Wall
		Grout Curtain
		Sheet Piling
COLLECTION	Extraction	Interceptor Trenches
		Extraction Wells
TREATMENT	Physical/Chemical	Aeration (Precipitation)
		Filtration
		Chemical Precipitation
		Air Stripping
		UV Oxidation
		Activated Carbon
		Ion Exchange
		Fixation (In situ)
		Air Sparging (In situ)*
		Electrolytic Sep. (In situ)*
	Biological	Constructed Wetland
		Bioremediation (In situ)*
		Fort Devens WWTP
		Ayer POTW
DISCHARGE	On Site	Fort Devens WWTP
		To Groundwater
	Off Site	Ayer POTW
		Plow Shop Pond
		Nonacoicus Brook

Notes:

*Innovative technology listed in USEPA VISITT Database.

WWTP = wastewater treatment plant
POTW = publicly owned treatment works
USEPA = U.S. Environmental Protection Agency

TABLE 3-6
DESCRIPTION OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/TECHNOLOGY	DESCRIPTION OF PROCESS OPTIONS
<u>No Action</u>	
None	No action taken to reduce risk.
<u>Minimal Action</u>	
Institutional Controls	<u>Zoning Restrictions</u>. Through administrative controls, zone land around Shepley's Hill Landfill to prohibit residential development.
	<u>Deed Restrictions</u>. Place deed restrictions on transferred land to prohibit future installation of drinking water wells.
Environmental Monitoring	<u>Groundwater Monitoring</u>. Perform water quality analyses to monitor contaminant concentrations and assess future environmental impacts.
Landfill Cap Maintenance	<u>Landfill Cap System Maintenance</u>. Continue to maintain existing landfill cap, complete any necessary repairs, and consider surface drainage improvements.
<u>Containment</u>	
Capping	<u>Composite Barrier</u>. A hydraulic barrier consisting of a flexible membrane liner in intimate contact with a low-permeability soil layer and covered with soil is installed over the landfill.
Hydraulic Barriers	<u>Slurry Wall</u>. Excavate a trench in overburden and fill with impervious backfill to provide a low-permeability cutoff wall.
	<u>Grout Curtain</u>. Drill boreholes in overburden or bedrock at a designed spacing and fill with high pressure grout to provide a low-permeability cutoff wall.
	<u>Sheet Piling</u>. Drive steel sheet piles into the overburden to provide a low-permeability cutoff wall.
<u>Collection</u>	
Extraction	<u>Interceptor Trenches</u>. Trenches, drains and piping used to passively collect (by gravity flow) groundwater. Trench installation is typically limited to a depth of approximately 40 feet, and cannot be used below the bedrock surface.

continued

TABLE 3-6
DESCRIPTION OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/TECHNOLOGY	DESCRIPTION OF PROCESS OPTIONS
	Extraction Wells. Install extraction wells to collect groundwater. Wells are typically installed using augers in unconsolidated soils, and coring for bedrock wells. Wells are usually completed by placing a well screen to the desired depth and placing sandpack between well screen and aquifer materials. Well screens are chosen based on the characteristics of the aquifer material in which the well is placed.
Treatment Physical/Chemical	Aeration (Precipitation). Aerate the extracted groundwater to oxidize and precipitate inorganic compounds (i.e., arsenic and iron). Precipitated compounds are removed by settling in a clarifier and/or filtration. Filtration. Use of a filter to remove total suspended solids and precipitated floc. Chemical Precipitation. Chemical precipitation removes dissolved metals from aqueous wastes by chemically converting the metals to an insoluble form. The process produces a metal precipitate sludge and a treated effluent. The insoluble precipitate is typically removed by settling in a clarifier and/or filtration. The most common precipitation processes are hydroxide, carbonate, and sulfide precipitation, and potassium permanganate oxidation/precipitation. Flocculation agents can be added to precipitation processes to encourage small suspended particles to agglomerate into larger particles that settle faster. Air Stripping. Air stripping removes VOCs from extracted groundwater by contacting contaminated water with large volumes of air. Contaminants are transferred from the liquid phase to the gas phase, and carried off with effluent air. UV Oxidation. UV oxidation involves the simultaneous application of UV radiation and chemical oxidants to degrade low concentrations of aqueous organics. Ozone and hydrogen peroxide have been documented as chemical oxidants.

continued

TABLE 3-6
DESCRIPTION OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/TECHNOLOGY	DESCRIPTION OF PROCESS OPTIONS
	Activated Carbon. Activated carbon adsorption is a physical separation process in which organic and inorganic materials are removed from wastewater by sorption (i.e., the attraction and accumulation of one substance on another). Contaminants are removed by sorption onto available granular-activated carbon sites.
	Ion Exchange. Metal ions are removed from solution by exchange with ions electrostatically attached to a solid resin material.
	Fixation (In situ). Injection of chemicals into the groundwater to change the redox potential and render contaminants immobile.
	Air Sparging (In situ). In situ air sparging removes VOCs from groundwater by forcing air into the saturated zone. Contaminants dissolved in the groundwater volatilize into the air stream, and are transported to the vadose zone where they can be collected by a soil vapor extraction system.
	Electrolytic Separation (In situ). A d.c. electric field is imposed across electrode pairs placed in the ground. Metal ions migrate toward the cathode where they concentrate. The concentrated solution of contaminants is removed with groundwater from extraction wells.
Biological	Constructed Wetland. Passive flow of contaminated groundwater through a constructed wetland. Inorganics can be removed from the groundwater by several natural wetland processes including filtration and uptake by plant roots, adsorption of contaminants onto inorganic soil, neutralization and precipitation of contaminants.
	Bioremediation (In situ). Introduces microorganisms, nutrients, and oxygen into the groundwater using a matrix of injection wells and recirculation techniques.
	Destroys organics through biodegradation, acclimation, degradation, or chemical conversion of organic wastes by either aerobic or anaerobic biological treatment processes.

continued

TABLE 3-6
DESCRIPTION OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/TECHNOLOGY	DESCRIPTION OF PROCESS OPTIONS
	Fort Devens WWTP. Transport untreated groundwater to Fort Devens WWTP for treatment. This plant is a primary wastewater treatment facility located on North Post.
	Ayer POTW. Transport untreated groundwater to Ayer POTW for treatment. This plant is an activated sludge facility.
Discharge	
On Site	Fort Devens WWTP. Transport treated groundwater to Fort Devens WWTP.
	To Groundwater. Reinject treated groundwater meeting Massachusetts discharge limits outside limits of contamination.
Off Site	Ayer POTW. Transport treated groundwater to Ayer POTW.
	Plow Shop Pond. Discharge of treated groundwater meeting Massachusetts discharge limits to Plow Shop Pond.
	Nonacoicus Brook. Discharge of treated groundwater meeting Massachusetts discharge limits to Nonacoicus Brook.

Notes:

VOCs = volatile organic compounds
UV = ultraviolet
WWTP = waste water treatment plant
POTW = publicly owned treatment works

Table 3-7
Screening of Groundwater Technologies

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

General Response Action/ Process Option	Applicability to: Site-Limiting Characteristics	Applicability to: Waste-Limiting Characteristics	Screening Status	Comments
No Action				
None	None. Easily implementable.	None.	Retained.	Required for consideration by NCP. Does not achieve remedial action objectives.
Minimal Action				
Zoning Restrictions	Can only be implemented on property transferred by the Army. Would prohibit residential development within restricted area.	None. Prevents future residential development.	Retained.	Retained for implementation on Army property. Does not prevent off-site migration of contaminated groundwater.
Deed Restrictions	Can only be implemented on property transferred by the Army. Would prohibit installation of residential wells within restricted area.	None. Prevents future residential ingestion of groundwater.	Retained.	Retained for implementation on Army property. Does not prevent off-site migration of contaminated groundwater.
Groundwater Monitoring	None. Easily implementable. Groundwater monitoring wells currently exist on site and may be used in a groundwater monitoring program.	None. Would enable assessment of changes in contaminant concentrations over time.	Retained.	Would be considered in conjunction with other technologies.

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Landfill Cover System Maintenance	None. Easily implementable. Conventional construction activities.	None. Will continue to reduce groundwater contamination, which will minimize off-site migration of contamination.	Retained.	Would be considered in conjunction with other technologies.
Containment Composite Barrier	None.	None.	Retained.	Would be considered in conjunction with other technologies.

continued

Table 3-7
Screening of Groundwater Technologies

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

General Response Action/ Process Option	Applicability to: Site-Limiting Characteristics	Applicability to: Waste-Limiting Characteristics	Screening Status	Comments
Slurry Wall	None. Implementable. Barriers have been used successfully at other sites. Generally used in conjunction with capping which has already been performed at SHL.	Barrier design would require consideration of groundwater contaminants that may degrade barrier over time. May reduce mobility of chemicals in groundwater. Could be used in conjunction with collection and treatment/disposal technologies to meet response objectives. Would minimize contaminated groundwater discharge to Plow Shop Pond.	Retained.	
Grout Curtain	Implementable. Compared to slurry wall, less controlled installation, and less likely to achieve an extensive low permeability seal in overburden. Effective at sealing fractures in bedrock.	Similar effectiveness as slurry wall.	Retained	Retained for use in bedrock only.

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

General Response Action/ Process Option	Applicability to: Site-Limiting Characteristics	Applicability to: Waste-Limiting Characteristics	Screening Status	Comments
Sheet Piling	Implementable. Compared to slurry wall, less controlled installation, less likely to achieve low permeability seal due to poor connections between the steel sheets.	Similar effectiveness as slurry wall.	Eliminated.	Not applicable to bedrock; inappropriate for deep overburden.
<u>Collection</u>				
Interceptor Trenches	Not implementable at SHL. Construction only practical to a depth of approximately 40 feet. Contaminated ground-water is deeper than 40 feet at several locations. Fine sands may create construction difficulties.	Effective technology to passively collect contaminated groundwater. Would prevent migration of contaminated groundwater.	Eliminated.	
Extraction Wells	None. Implementable. Commonly used technology. Produces very little contaminated soil requiring disposal.	None. Effective mechanism to collect contaminated groundwater. Would prevent migration of contaminated groundwater.	Retained.	Several wells would have to be strategically located so that the cones of depression intersect and capture all contaminated groundwater.

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Treatment				
Aeration	None. Easily implementable for extracted groundwater. Precipitated sludge may require disposal at a RCRA TSD facility.	None. Effective method for oxidation and precipitation of arsenic and iron. Requires chemical oxidant to be effective for manganese. Groundwater may require additional treatment to achieve Maximum Contaminant Levels (MCLs).	Retained.	
Filtration	None. Easily implementable for extracted groundwater. Filtered solids may require disposal at a RCRA TSD Facility	None. Effective for removal of total suspended solids and precipitated floc.	Retained	

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO: SITE-LIMITING CHARACTERISTICS	APPLICABILITY TO: WASTE-LIMITING CHARACTERISTICS	SCREENING STATUS	COMMENTS
Chemical Precipitation	None.	None.	Retained.	
	Easily implementable for extracted groundwater.	Effective treatment for removing the groundwater contaminants (As, Fe, Mn). Precipitation may also remove low levels of a few organics in groundwater.		
	Precipitated heavy metal sludge would require treatment/disposal.	Groundwater may require additional treatment to achieve MCLs.		
Air Stripping	None.	Does not provide effective treatment for the primary groundwater contaminants (As, Fe, Mn).	Eliminated.	
	Easily implementable commonly used technology.			
UV Oxidation	None.	Does not provide effective treatment for the primary groundwater contaminants (As, Fe, Mn).	Eliminated.	
	Implementable. Commonly used technology. Self-contained and mobile units available.			

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO: SITE-LIMITING CHARACTERISTICS	APPLICABILITY TO: WASTE-LIMITING CHARACTERISTICS	SCREENING STATUS	COMMENTS
Activated Carbon	None. Implementable. Commonly used technology. Self contained and mobile units available. Waste carbon considerably more toxic than influent water, special disposal, regeneration or destruction is required.	Primarily a treatment for organic contaminants. Not proven effective for inorganics.	Retained	Retained as a pretreatment step to improve ion exchange system performance. Will also provide treatment for 1,2-dichloroethane and dichlorobenzenes
Ion Exchange	None. Implementable. Self-contained, mobile units available. High technical feasibility and demonstrated performance.	None. Effectively removes As, Mn, Fe, and inorganics from groundwater.	Retained.	

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
	Resin regeneration brine is considerably more toxic than influent water; special disposal or destruction is required.	Resins are often selective, and may be susceptible to fouling by high concentrations of TSS, and precipitated inorganics. Filtration prior to treatment may be required.		
Fixation (In situ)	Shallow groundwater in several locations at SHL may limit injection capacity. Wells may become plugged by precipitation of minerals caused by chemical reactions of soil/aquifer constituents with injected nutrients. Does not require groundwater extraction.	None. Hydrogen peroxide has been shown to effectively oxidize Fe. As has been shown to co-precipitate with Fe.	Retained.	
Air Sparging (In situ)	Could impact integrity of cap at SHL. Would not meet remedial response objectives. Does not require groundwater extraction.	Not effective treatment for inorganics.	Eliminated.	

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Electrolytic Separation (In situ)	Large power requirements. Does not require groundwater extraction	Has been demonstrated effective for removal of ionized inorganics at bench scale. Innovative technology. Not proven at full scale.	Eliminated.	
Constructed Wetland	None. Low maintenance. Large spatial require-ments to ensure low flow rates, and minimal depth of water in wetland.	Natural and constructed wetlands have been proven effective at removing some inorganics (i.e., Fe, Mn) from groundwater through natural processes. Effectiveness for removal of arsenic is not proven. Inorganics would be concentrated in wetland soil and organic material.	Retained.	
Bio-remediation (In situ)	Wells may become plugged by precipitation of minerals caused by chemical reactions of soil/aquifer constituents with injected nutrients.	Biological treatment will not remove arsenic, iron or manganese, the primary groundwater contaminants.	Eliminated.	

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
	Does not require groundwater extraction.			
Fort Devens WWTP	Would require piping groundwater to existing Fort Devens sewer system.	Fort Devens has a primary wastewater treatment facility, not designed to treat inorganics.	Eliminated.	
Ayer POTW	Would require piping groundwater to Ayer sewer system.	None. It is estimated that hydraulic capacity exists, and that untreated groundwater would meet pre-treatment standards for Ayer POTW.	Retained.	Preliminary discussions with the POTW indicate a willingness to consider accepting extracted groundwater if pretreatment requirements are met.
Discharge Fort Devens WWTP	Would require piping groundwater to existing Fort Devens sewer system. Facility currently has a notice of non-compliance.	Fort Devens has a primary wastewater treatment facility not designed to treat inorganics.	Eliminated.	

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
To Groundwater	Limited by recharge/ permeability rates of soils and availability of suitable nearby discharge site. On-site discharge of treated groundwater would reduce administrative burden of obtaining discharge permit.	None, as long as water has been treated to acceptable discharge standards (most likely MCLs).	Eliminated.	Only available discharge location is north of SHL. Water table is approximately 5 feet bgs and mounding could result in runoff into Nonacoicus Brook.
Ayer POTW	Would require piping groundwater to Ayer sewer system.	None. It is estimated that hydraulic capacity exists and treated groundwater would meet pretreatment standards for Ayer POTW.	Retained.	Preliminary discussions with the POTW indicate a willingness to consider accepting extracted groundwater if pretreat-ment requirements are met.
Plow Shop Pond	Negative public perception may exist for discharge to Plow Shop Pond.	None. If contaminants are treated to acceptable limits.	Eliminated.	

continued

TABLE 3-7
SCREENING OF GROUNDWATER TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/ PROCESS OPTION	APPLICABILITY TO		SCREENING STATUS	COMMENTS
	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS		
Nonacoicus Brook	NPDES permit required for off-site discharge to Nonacoicus Brook. Estimated 60 dilutions available in brook at 7Q10 flow.	None. If contaminants are treated to acceptable limits.	Retained.	Nonacoicus Brook provides greater opportunity for discharge mixing than does Plow Shop Pond.

Notes:

NCP	=	National Contingency Plan
MCLs	=	maximum contaminant levels
As	=	Arsenic
Mn	=	Manganese
Fe	=	Iron
TDS	=	total dissolved solids
WWTP	=	waste water treatment plant
POTW	=	publicly owned treatment works
BOD	=	biological oxygen demand
SHL	=	Shepley's Hill Landfill
CSBL	=	Cold Spring Brook Landfill
NPDES	=	National Pollutant Discharge Elimination System
RCRA	=	Resource Conservation and Recovery Act
TSD	=	treatment, storage and disposal
UV	=	ultraviolet
TSS	=	total suspended solids
bgs	=	below ground surface
7Q10	=	Average 7-day 10-year low flow

TABLE 3-8
SCREENING SUMMARY OF TECHNOLOGIES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

GENERAL RESPONSE ACTION/PROCESS OPTION	RETAINED	ELIMINATED
GROUNDWATER		
No Action		
None	X	
Minimal Action		
Zoning Restrictions	X	
Deed Restrictions	X	
Groundwater Monitoring	X	
Landfill Cover System Maintenance	X	
Containment		
Composite Barrier	X	
Slurry Wall	X	
Grout Curtain	X	X
Sheet Piling		
Collection		
Interceptor Trench		X
Extraction Wells	X	
Treatment		
Aeration	X	
Filtration	X	
Chemical Precipitation	X	
Air Stripping		X
UV Oxidation		X
Activated Carbon	X	
Ion Exchange	X	
Fixation (In situ)	X	
Air Sparging (In situ)		X
Electrolytic Separation (In situ)		X
Constructed Wetland	X	
Bioremediation (In situ)		X
Fort Devens WWTP		X
Ayer POTW	X	
Discharge		
Fort Devens WWTP		X
Groundwater		X
Ayer POTW	X	
Plow Shop Pond		X
Nonacoicus Brook	X	

Notes:

UV = ultraviolet
WWTP = wastewater treatment plant
POTW = publicly owned treatment works
RCRA = Resource Conservation and Recovery Act
TSD = treatment, storage and disposal

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SECTION 4.0

Table 4-1
Comparison of Volumetric Budget for Low and High Pond Elevations

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Cumulative Volumes	Alternate Boundary	Low Pond Elevation	High Pond Elevation
IN			
Storage	0.00000	0.00000	0.00000
Constant Head	84,765	88,199	82,736
Recharge	33,231	33,231	33,231
River Leakage	2,792	1,492	6,027
Head DEP Bounds	0.00000	0.00000	0.00000
Total In	120,788	122,923	121,976
OUT			
Storage	0.00000	0.00000	0.00000
Constant Head	88,970	80,080	99,320
Recharge	0.00000	0.00000	0.00000
River Leakage	21,274	34,176	10,218
Head DEP Bounds	10,346	8,591	12,126
Total Out	120,590	122,847	121,664
In - Out	198	76	312
Percent Discrepancy	0.16	0.06	0.26

Notes: Volumes are cubic feet per day.

TABLE 4-2
SUMMARY OF GROUNDWATER MODELING SIMULATION RUNS

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

RUN IDENTIFICATION	SIMULATED CONDITIONS		CORRESPONDING FIGURE
Partial walls:			
Pwa1101	A partial wall 1,120 feet long in overburden along the eastern perimeter of the landfill		4-16
Pwa1102	A partial wall 800 feet long in overburden along the eastern perimeter of the landfill		4-17
Pwa1103	A partial wall 1,800 feet long angled to extend past the SE corner of the landfill		4-18
Pwa1104	A partial wall 2,040 feet long similar to Pwa1103, but which wraps around the southern corner of the landfill		4-19
Upgradient drains:			
Drain	a)	An upgradient drain 10 feet into rock along about a 700-foot length of the western side of the landfill	4-20 and 4-21
Drain	b)	Same as a), but 20-foot deep drain	4-20 and 4-21
Drain	c)	Same as a), but 30-foot deep drain	4-20 and 4-21
Injection simulation:			
Reinj01	Injection of 20 gpm at north end of landfill		4-22
Reinj02	Injection of 40 gpm at north end of landfill		4-23
Drain1	Same as Reinj01 with north-south drain added		4-24
Drain2	Same as Drain1 with two 200-foot diversion walls added		4-25
Drain3	Same as Drain2 with inner drains added to diversion walls		

(continued)

TABLE 4-2
SUMMARY OF GROUNDWATER MODELING SIMULATION RUNS

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

RUN IDENTIFICATION	SIMULATED CONDITIONS	CORRESPONDING FIGURE
Pumping simulations:		
Pump01	Extraction well at north end of landfill at 10 gpm	No Figure
Pump02	Same as Pump01, but with pumping at 20 gpm	4-26 and 4-27
Pump03	Single well at 20 gpm near "L" at SE corner of landfill	No Figure
Pump04	Same as Pump03, but at 40 gpm	No Figure
Pump05	Two extraction wells at SE corner of landfill, one at 15 gpm and the second at 25 gpm	4-28 and 4-29
Pump06	Same as Pump01, but at 15 gpm	No Figure
Other particle tracking:		
SSfinal	Steady-state conversion of final calibrated model to show particle tracks after capping	4-5
Nocap	Steady-state version of ETA's uncapped model run, converted to allow particle tracking	4-6

Table 4-3
Alternative SHL-2: Limited Action

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

This alternative does not provide any remedial actions to treat groundwater. Zoning and deed restrictions, along with landfill cover system maintenance will reduce potential for exposure. Long-term groundwater and landfill gas monitoring and five-year site reviews are included.

Effectiveness	Implementability	Cost
Advantages	Advantages	Advantages
• Groundwater does not currently pose a drinking water risk because no residential receptors exist.	• Easy to implement zoning and deed restrictions on Army property.	• Low capital costs.
• Zoning and deed restrictions would prevent future exposure to groundwater.	• No impediments to meeting action-specific ARARs are expected.	• Low O&M costs for long-term groundwater monitoring and five-year site reviews.
• Low potential for short-term worker exposure to contaminants during implementation.	• Cover system repairs, drainage improvements and groundwater monitoring would be easily implemented.	
• Landfill cover system will reduce the mobility of contaminants.		
• Groundwater modeling suggests that capping of landfill has: (1) significantly reduced the total amount of water in the landfill area; and (2) almost totally diverted groundwater flow from the landfill away from the northern portions of Plow Shop Pond.		
Disadvantages	Disadvantages	Disadvantages
• Does not reduce toxicity or volume of contaminants.	• May require future groundwater treatment.	• Potential for future remedial action costs.

continued

TABLE 4-3
ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

EFFECTIVENESS	IMPLEMENTABILITY	COST
	• Not consistent with SARA's preference for treatment.	

ESTIMATED CAPITAL COST $928,000

ESTIMATED PRESENT WORTH OF O&M COSTS $1,291,000

ESTIMATED TOTAL PRESENT WORTH $2,219,000

CONCLUSION: This alternative will be **retained** for detailed analysis because it provides administrative controls to protect human health at a low cost.

Notes:

SARA	=	Superfund Amendments and Reauthorization Act
O&M	=	Operations and maintenance

TABLE 4-4
ALTERNATIVE SHL-3: CONTAINMENT/COLLECTION/SHORT-TERM EX SITU TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

This alternative involves construction of a 4,500-ft.-long slurry wall and a 2,500- ft.-long grout curtain around the waste in conjunction with the existing cover system. The slurry wall and grout curtain should reduce future groundwater contamination by diverting clean groundwater away from landfilled waste. Alternative SHL-3 also includes installation of extraction wells upgradient of the slurry wall and short-term groundwater treatment. Limited action components are included.

EFFECTIVENESS	IMPLEMENTABILITY	COST
Advantages	Advantages	Advantages
• None	• Slurry walls, grout curtains, and extraction wells are commonly implemented technologies. • No impediments to meeting action-specific ARARs are expected. • Proposed depths for slurry wall and grout curtain are within the range of available equipment.	• Moderate O&M costs for long-term groundwater monitoring and five- year site reviews.
Disadvantages	Disadvantages	Disadvantages
• Groundwater modeling indicates that much of the overburden is unsaturated. Installation of a grout curtain and slurry wall would only lead to minimal additional lowering of the groundwater table. • Not keying slurry wall into bedrock may allow some leakage, and groundwater flow may occur beneath the bottom of the grout curtain. • Time required to achieve response objectives and target levels in groundwater is not known.	• Extensive bedrock investigations required prior to installation of grout curtain. • Tying slurry wall into existing cap would require excavation of periphery cap materials and additional PVC membrane. • Extraction wells and treatment system will require long-term operation and maintenance.	• High capital costs for slurry wall, grout curtain, extraction wells and treatment system.

continued

Table 4-4
Alternative SHL-3: Containment/Collection/Short-term Ex situ Treatment/Surface Water Discharge

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Effectiveness	Implementability	Cost
• Potential for short-term worker exposure to contaminated groundwater during slurry wall construction and installation of extraction wells.	• Cut and fill may be required to achieve <1% ground surface grade for slurry wall.	
• Hydrogeologic evaluation of slurry wall and grout curtain effectiveness must be done.	• May require surface water discharge permit.	
	• Installation of discharge pipe to Nonacoicus Brook would require crossing floodplains and delineated wetland.	

CONCLUSION: This alternative will be **eliminated** due to the ineffectiveness of the containment components as demonstrated through groundwater modeling.

Note:

O&M = Operations and maintenance

TABLE 4-5
ALTERNATIVE SHL-4: CONTAINMENT/IN SITU OXIDATION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

This alternative involves construction of a 4,500-ft.-long slurry wall and a 2,500-ft.-long grout curtain around the waste in conjunction with the existing cover system. The slurry wall and grout curtain should reduce future groundwater contamination by diverting clean groundwater away from the landfilled waste. Alternative SHL-4 also includes installation of groundwater injection wells at the north end of the landfill, to be used for injection of hydrogen peroxide to treat groundwater by in situ fixation.

EFFECTIVENESS	IMPLEMENTABILITY	COST
Advantages	Advantages	Advantages
• Although in situ oxidation has not been used full scale at hazardous waste sites, the chemistry of As co-precipitation with Fe has been proven.	• Slurry walls, grout curtains, and injection wells are commonly implemented technologies.	• Potential low capital and O&M costs for in situ fixation treatment.
	• No impediments to meeting action-specific ARARs are expected.	• Moderate O&M costs for long-term groundwater monitoring and five-year site reviews.
• In situ oxidation should reduce toxicity and mobility of As by converting it to its less toxic, oxidized form.	• Proposed depths for slurry wall and grout curtain are within the range of available equipment.	
	• Vendors for in situ aquifer treatment technologies are available.	
	• Hydrogen peroxide and potable water readily available.	
	• Treatment system can be operated relatively unattended.	
	• No groundwater extraction required.	
	• No treatment residuals requiring off-site disposal.	

TABLE 4-5
ALTERNATIVE SHL-4: CONTAINMENT/IN SITU OXIDATION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

EFFECTIVENESS	IMPLEMENTABILITY	COST
Disadvantages	Disadvantages	Disadvantages
• Groundwater modeling indicates that much of the overburden is unsaturated. Installation of a grout curtain and slurry wall would only lead to minimal additional lowering of the groundwater table.	• Extensive bedrock investigations required prior to installation of grout curtain.	
• Modeling indicated that injection wells would not be effective for injection of hydrogen peroxide.	• Tying slurry wall into existing cap would require excavation of periphery cap materials and additional PVC membrane.	
• Not keying slurry wall into bedrock may allow some leakage and groundwater flow may occur beneath the bottom extent of the grout curtain.	• In situ oxidation has not been implemented full scale.	
• Time required to achieve response objectives and target levels in groundwater is not known.	• Shallow groundwater table at SHL may limit implementability if significant mounding were to occur.	
• Potential for short-term worker exposure to contaminated groundwater during slurry wall construction.	• Precautions for on site storage and handling of hydrogen peroxide required.	
• Hydrogeologic evaluation of slurry wall and grout curtain effectiveness must be done.	• Potential for clogging of injection wells may require that a "buffer" be set up around the well.	
• Treatability study recommended to confirm feasibility for site specific conditions.	• Redundant wells may be required to account for servicing clogged wells.	

TABLE 4-5
ALTERNATIVE SHL-4: CONTAINMENT/IN SITU OXIDATION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

EFFECTIVENESS	IMPLEMENTABILITY	COST
	• Long-term treatment required. • Cut and fill may be required to achieve <1% ground surface grade for slurry wall. • Injection wells may be located within the 100 year floodplain.	

CONCLUSION: This alternative will be **eliminated** due to the ineffectiveness of the containment components and injection wells as demonstrated through groundwater modeling.

Notes:

SHL	=	Shepley's Hill Landfill
As	=	Arsenic
Fe	=	Iron
O&M	=	Operations and Maintenance
PVC	=	Polyvinyl Chloride

Table 4-6
Alternatives SHL-5A and SHL-5B: Collection/Ion Exchange Treatment/Surface Water Discharge

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

This alternative involves installation of groundwater extraction and ion exchange treatment system. Water would be pumped from an extraction well placed at the northern end of the landfill to an Ion Exchange Treatment System for inorganics removal. Limited action components are included.

Effectiveness	Implementability	Cost
Advantages	Advantages	Advantages
• Reduces toxicity, mobility, and volume of contaminants in groundwater by long term treatment.	• Extraction wells are commonly implemented technologies.	• None.
• Demonstrated effective treatment for removal of inorganic contaminants.	• Ion exchange technology services and resin materials readily available.	
• Meets remedial action objectives.	• No impediments to meeting action-specific ARARs are expected.	
• Contaminants removed onto a resin, low potential for short term risks to workers.		
Disadvantages	Disadvantages	Disadvantages
• Effectiveness may be limited by TDS, pH of groundwater, and valence state of inorganics.	• Aquifer tests required to design extraction system.	• High capital and O&M costs for extraction wells, treatment facility, and long term groundwater treatment and monitoring.
• Treatability study recommended to determine most effective resin for waste stream.	• Long-term treatment required.	
• Time required to achieve response objectives and target levels in groundwater is not known.	• Extraction wells and treatment system will require long-term operation and maintenance.	
• Resin regeneration brine will require treatment or disposal.	• Discharge pipe to Nonacoicus Brook would cross delineated floodplains and wetlands.	

continued

TABLE 4-6
ALTERNATIVES SHL-5A AND SHL-5B: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

EFFECTIVENESS	IMPLEMENTABILITY	COST
• Potential for high iron concentrations to foul resin, may require pretreatment to remove some iron.		

ESTIMATED CAPITAL COST $2,577,000

ESTIMATED PRESENT WORTH OF O&M COST $6,549,000

ESTIMATED TOTAL PRESENT WORTH $9,126,000

CONCLUSION: This alternative will be **retained** because it provides a demonstrated effective process to reduce levels of inorganic contamination in groundwater. This alternative would meet remedial action objectives.

Notes:

TDS = total dissolved solids
O&M = operations and maintenance

Table 4-7
Alternative SHL-6: Collection/Chemical Precipitation Treatment/Surface Water Discharge

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

This alternative involves installation of a groundwater extraction and chemical precipitation treatment system. Water would be pumped from an extraction well placed at the northern end of the landfill to a Chemical Precipitation Treatment System for inorganics removal. Limited action components are included.

Effectiveness	Implementability	Cost
Advantages	Advantages	Advantages
• Reduces toxicity, mobility, and volume of inorganics in groundwater by long-term treatment.	• Extraction wells are commonly implemented technologies.	• None.
• Demonstrated effective treatment for removal of inorganic contaminants.	• Chemical precipitation is a conventional technology and equipment and chemicals are readily available.	
• Meets remedial action objectives.	• Systems can accommodate a variety of flow rates.	
• Low potential for short-term worker exposure during groundwater treatment.	• No impediments to meeting action-specific ARARs are expected.	
Disadvantages	Disadvantages	Disadvantages
• Treatability study recommended to determine most effective chemical precipitant for waste stream.	• Aquifer tests required to design extraction system.	• High capital and O&M costs for extraction wells, and treatment facility, and long-term groundwater treatment and monitoring.
• Time required to achieve response objectives and target levels in groundwater is not known.	• Chemical environment for the precipitation process must be strictly controlled and monitored to maintain correct operating conditions.	
• Heavy metal sludge is produced by precipitation process; sludge will require further treatment or disposal.	• Long-term treatment required.	

TABLE 4-7
ALTERNATIVE SHL-6: COLLECTION/CHEMICAL PRECIPITATION TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

EFFECTIVENESS	IMPLEMENTABILITY	COST
• Potential for short-term worker exposure to contaminated groundwater during slurry wall construction and installation of extraction wells.	• Extraction wells and treatment system will require long-term maintenance.	
	• May require surface water discharge permit.	
	• Discharge pipe to Nonacoicus Brook would cross delineated floodplains and wetlands.	

CONCLUSION: This alternative will be **eliminated** for detailed analysis because preliminary vendor information indicates that Alternative SHL-5 ion exchange treatment may be more efficient.

Note:

O&M = operations and maintenance

TABLE 4-8

ALTERNATIVE SHL-7: COLLECTION/CONSTRUCTED WETLAND TREATMENT/SURFACE WATER DISCHARGE

FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

This alternative involves installation of a groundwater extraction system and construction of a wetland. Water would be pumped from an extraction well placed on the northern end of the landfill to a wetland constructed on site for the purpose of treating groundwater by natural processes. Limited Action components are included.

EFFECTIVENESS	IMPLEMENTABILITY	COST
Advantages	Advantages	Advantages
• None.	• Extraction wells are commonly implemented technologies.	• Estimated capital costs for wetland treatment would be lower than other treatment alternatives.
	• Construction of the wetland requires conventional construction techniques. Equipment and materials are readily available.	• Moderate O&M costs for long-term surface groundwater monitoring and five-year site reviews.
	• No impediments to meeting action-specific ARARs are expected.	
Disadvantages	Disadvantages	Disadvantages
• Although proven effective at removing moderate percentages of Fe, Cu, Zn, and Mn; not demonstrated effective at removing As and other inorganics.	• Aquifer tests required to design extraction system.	• Potential additional capital costs for storage tanks if wetland does not function year round.
• Reduction of mobility, toxicity, and volume of contaminated groundwater uncertain.	• Constructed wetland may not function effectively during periods of heavy rain or in the winter.	• Potential additional O&M costs for disposal of accumulated biomass with concentrated contamination.
• Time required to achieve response objectives and target levels in groundwater is not known..	• Long-term monitoring of surface water as it exits wetland to assess contaminant removal.	• Potential costs for additional treatment if wetland is not effective.
• Pilot testing recommended to determine wetlands effectiveness at removing arsenic and other inorganics and treatment time.	• Potential disposal of accumulated biomass.	
• Potential for ecological exposure to contaminated groundwater during wetlands operation.	• Long-term pilot testing could impact schedules specified in the IAG.	

continued

TABLE 4-8
ALTERNATIVE SHL-7: COLLECTION/CONSTRUCTED WETLAND TREATMENT/SURFACE WATER DISCHARGE

FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

EFFECTIVENESS	IMPLEMENTABILITY	COST
• Potential for short-term worker exposure to contaminated groundwater during construction, extraction well installation, and while groundwater is in wetland.	• May require future groundwater treatment if wetland is not effective.	
	• Extraction wells would require long-term operation and maintenance.	
	• Discharge pipe to Nonacoicus Brook would cross delineated floodplains and wetlands.	

CONCLUSION: This alternative will be **eliminated** from further consideration based on the fact that it has not been demonstrated effective at removing arsenic and possibly other inorganics in groundwater at Shepley's Hill Landfill.

Note:

O&M	=	operations and maintenance
Fe	=	Iron
Cu	=	Copper
Zn	=	Zinc
Mn	=	Manganese
As	=	Arsenic

TABLE 4-9
ALTERNATIVE SHL-8: GROUNDWATER BARRIER/IN SITU OXIDATION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

Alternative SHL-8 involves installation of a 1,600-ft.-long slurry wall to block continued groundwater flow into Plow Shop Pond and to divert groundwater to the north. Injection wells would be installed at the north end of the landfill and used for injection of hydrogen peroxide to treat groundwater by in situ fixation.

EFFECTIVENESS	IMPLEMENTABILITY	COST
Advantages	Advantages	Advantages
• Long-term in situ oxidation treatment should reduce toxicity and mobility of As by converting it to its less toxic, oxidized form.	• Slurry walls and injection wells are commonly implemented technologies.	• Potential for low capital and O&M costs for in situ oxidation treatment.
• Although in situ oxidation treatment has not been used full scale at hazardous waste sites, the chemistry of As co-precipitation with Fe has been proven.	• Proposed depths for slurry wall are within the range of available equipment.	• Moderate O&M costs for long-term groundwater monitoring and five-year site reviews.
	• No impediments to meeting action-specific ARARs are expected.	
• May meet remedial action objectives.	• Vendors for in situ aquifer treatment technologies are available.	
	• Hydrogen peroxide and potable water readily available.	
	• Treatment system can be operated relatively unattended.	
	• No groundwater extraction required.	
	• No treatment residuals requiring off-site disposal.	

continued

TABLE 4-9
ALTERNATIVE SHL-8: GROUNDWATER BARRIER/IN SITU OXIDATION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

EFFECTIVENESS	IMPLEMENTABILITY	COST
Disadvantages	Disadvantages	Disadvantages
• Groundwater modeling indicates that much of the overburden is unsaturated. Installation of a grout curtain and slurry wall would only lead to minimal additional lowering of the groundwater table.	• In situ fixation has not been implemented full scale.	• High capital costs for slurry wall and reinjection wells.
	• Injection wells may be constructed in the 100-year floodplain.	
• Modeling indicates that injection wells would not be effective for injection of hydrogen peroxide.	• Long-term treatment required.	
• Time required to achieve response objectives and target levels in groundwater is not known.	• Shallow water table at SHL may limit implementability if significant mounding were to occur.	
• Treatability study recommended to confirm site specific conditions.	• Precautions for on site storage and handling of hydrogen peroxide required.	
• Potential for short-term worker exposure to contaminated groundwater during slurry wall construction.	• Potential for clogging of injection wells may require that a "buffer" be set up around the well.	
	• Redundant wells may be required to account for servicing clogged wells.	

CONCLUSION: This alternative will be **eliminated** due to the ineffectiveness of the barrier components and injection wells as demonstrated through groundwater modeling.

Notes:

As = Arsenic
Fe = Iron
O&M = operations and maintenance

TABLE 4-10
ALTERNATIVES SHL-9A AND SHL-9B: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

This alternative involves installation of a groundwater extraction and discharge system. Water would be pumped from an extraction well placed at the northern end of the landfill to the Ayer POTW. Limited action components are included.

EFFECTIVENESS	IMPLEMENTABILITY	COST
Advantages	Advantages	Advantages
• Mobility and volume of contaminants in groundwater discharged to the POTW should be reduced.	• Extraction wells are commonly implemented technologies.	• No capital cost for treatment.
• Should meet remedial action objectives.		• Moderate O&M costs for long-term POTW user fee, and O&M for extraction wells, long-term groundwater monitoring and five-year site reviews.
	• No impediments to meeting action-specific or location-specific ARARs are expected.	
Disadvantages	Disadvantages	Disadvantages
• Continued monitoring of extracted groundwater required to assure that pretreatment standards are met.	• Aquifer tests required to design extraction system.	
• Time required to achieve response objectives and target levels in groundwater is not known.	• Requires successful negotiation of long-term discharge agreement with Ayer POTW.	
	• Pretreatment of groundwater may be required.	
	• Not consistent with SARA's preference for treatment.	

ESTIMATED CAPITAL COST $1,184,000

ESTIMATED PRESENT WORTH OF O&M COSTS $2,690,000

ESTIMATED TOTAL PRESENT WORTH $3,874,000

CONCLUSION: These alternatives will be **retained**. As long as the extracted groundwater meets pretreatment standards for the Ayer POTW, remedial action objectives, including ARARs, would be met.

Notes:

POTW	=	publicly owned treatment works
SARA	=	Superfund Amendments and Reauthorization Act
O&M	=	operations and maintenance

TABLE 4-11
ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

This alternative does not provide any remedial actions to treat groundwater. Zoning and deed restrictions, along with installation and maintenance of a new landfill cover system will reduce potential for exposure. Long-term groundwater and landfill gas monitoring and five-year site reviews are included.

EFFECTIVENESS	IMPLEMENTABILITY	COST
Advantages	Advantages	Advantages
• Groundwater does not currently pose a drinking water risk because no residential receptors exist.	• Easy to implement zoning and deed restrictions on Army property.	
• Zoning and deed restrictions would prevent future exposure to groundwater.	• No impediments to meeting action-specific ARARs are expected.	• Low O&M costs for long-term groundwater monitoring and five year site reviews.
	• Groundwater and landfill gas monitoring would be easily implemented.	
• Landfill cover system will reduce the mobility of contaminants.		
• Effectiveness at reducing infiltration and diverting groundwater flow should be similar to existing cover.		
Disadvantages	Disadvantages	Disadvantages
• Does not reduce toxicity or volume of contaminants.	• May require future groundwater treatment.	• High capital cost.

TABLE 4-11
ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

EFFECTIVENESS	IMPLEMENTABILITY	COST
• Installation of new cover system may pose short-term risks to workers, community, and the environment.	• Not consistent with SARA's preference for treatment.	• Potential for future remedial action costs.

ESTIMATED CAPITAL COST $19,645,000

ESTIMATED PRESENT WORTH OF O&M COSTS $1,291,000

ESTIMATED TOTAL PRESENT WORTH $20,936,000

CONCLUSION: This alternative will be **retained** for detailed analysis because it is protective of human health and is based on RCRA design guidance.

Notes:

SARA = Superfund Amendments and Reauthorization Act
O&M = Operations and maintenance

TABLE 4-12
SCREENING SUMMARY OF ALTERNATIVES

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

REMEDIAL ALTERNATIVES	RETAINED	ELIMINATED
Alternative SHL-1: No Action	X	
Alternative SHL-2: Limited Action	X	
Alternative SHL-3: Containment/Collection/ Short-term Ex Situ Treatment/Surface Water Discharge		X
Alternative SHL-4: Containment/In Situ Oxidation		X
Alternative SHL-5: Collection/Ion Exchange Treatment/Surface Water Discharge	X	
Alternative SHL-6: Collection/Chemical Precipitation Treatment/Surface Water Discharge		X
Alternative SHL-7: Collection/Constructed Wetland Treatment/Surface Water Discharge		X
Alternative SHL-8 Groundwater Barrier/In Situ Oxidation		X
Alternative SHL-9 Collection/Discharge to POTW	X	
Alternative SHL-10 Installation of RCRA Cap	X	

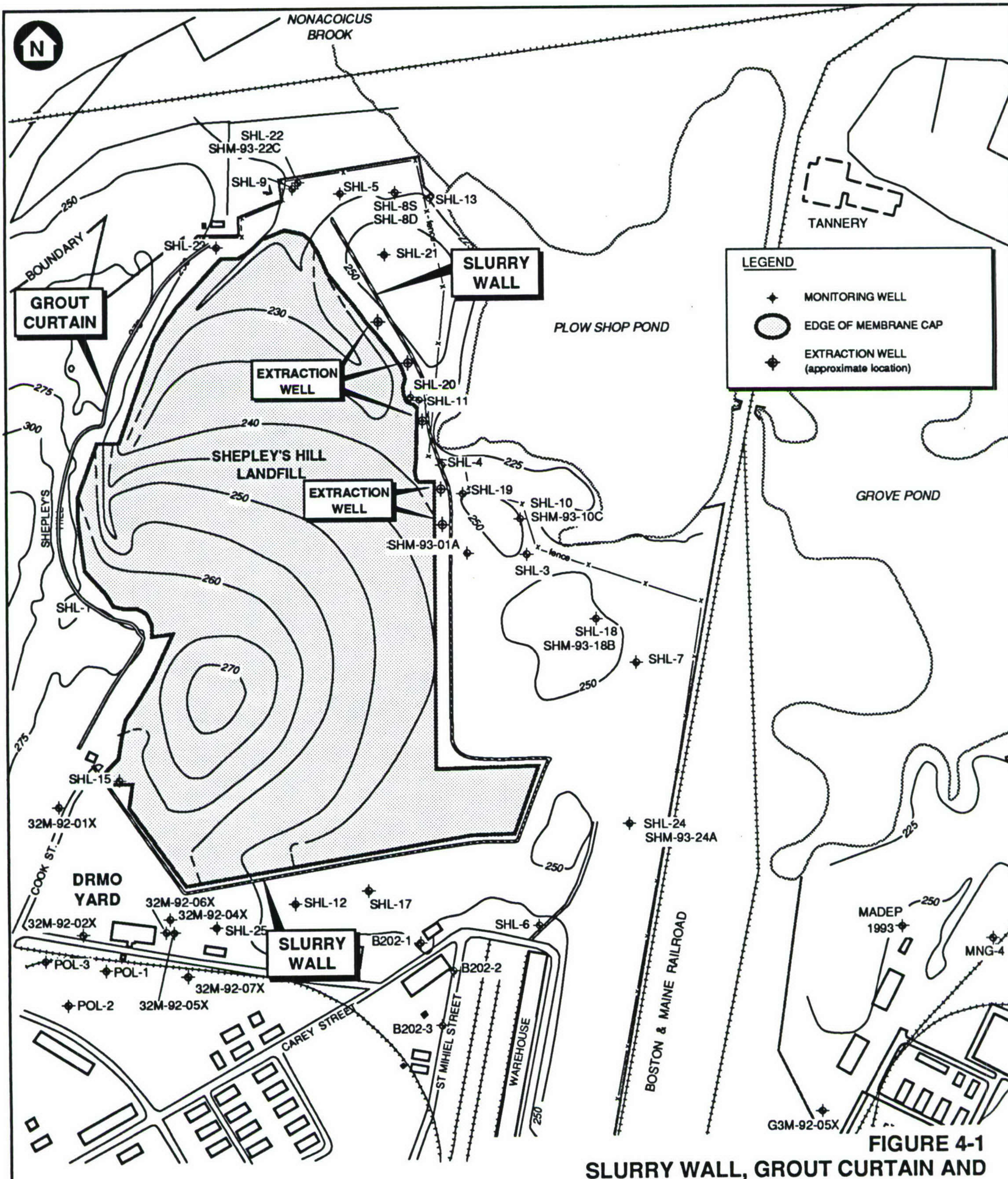


FIGURE 4-1
SLURRY WALL, GROUT CURTAIN AND EXTRACTION WELLS FOR ALTERNATIVE SHL-3
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

9403007D 1 S6 H L

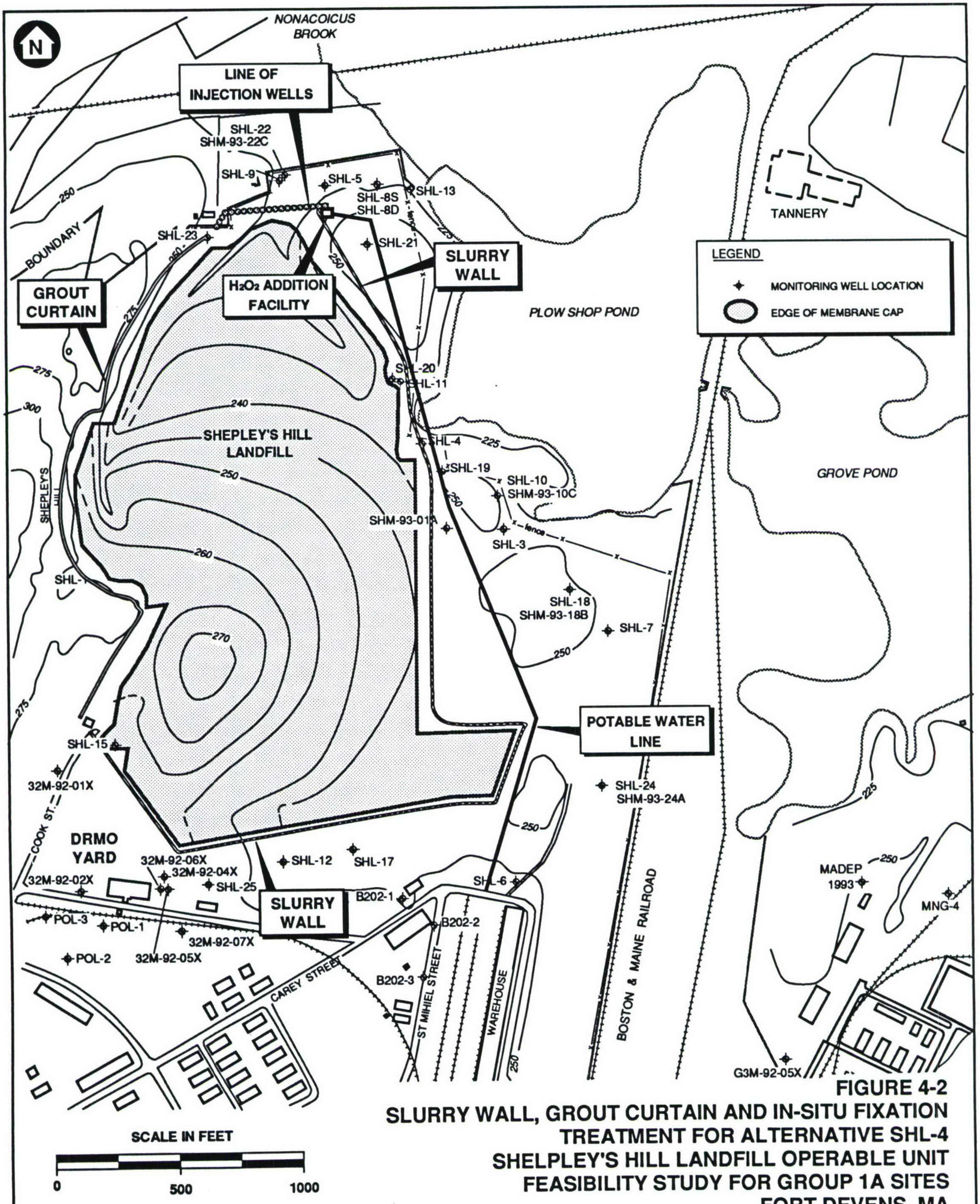


FIGURE 4-2
SLURRY WALL, GROUT CURTAIN AND IN-SITU FIXATION TREATMENT FOR ALTERNATIVE SHL-4
SHELPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

9403007D 1 S6 K

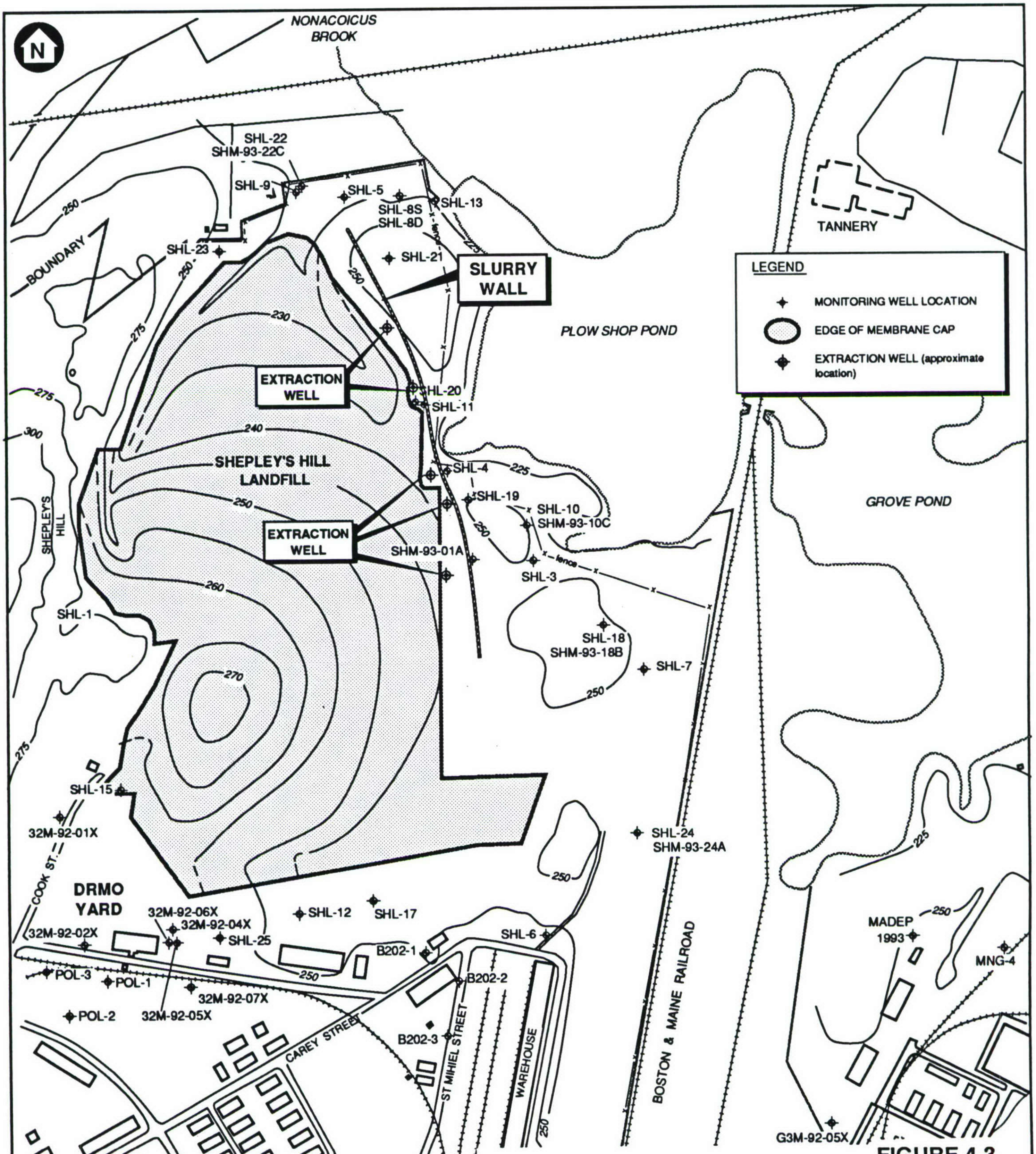


FIGURE 4-3
SLURRY WALL AND EXTRACTION WELLS FOR ALTERNATIVES SHL5, 6 ,7, AND 9
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

9403007D 1 S6 F M

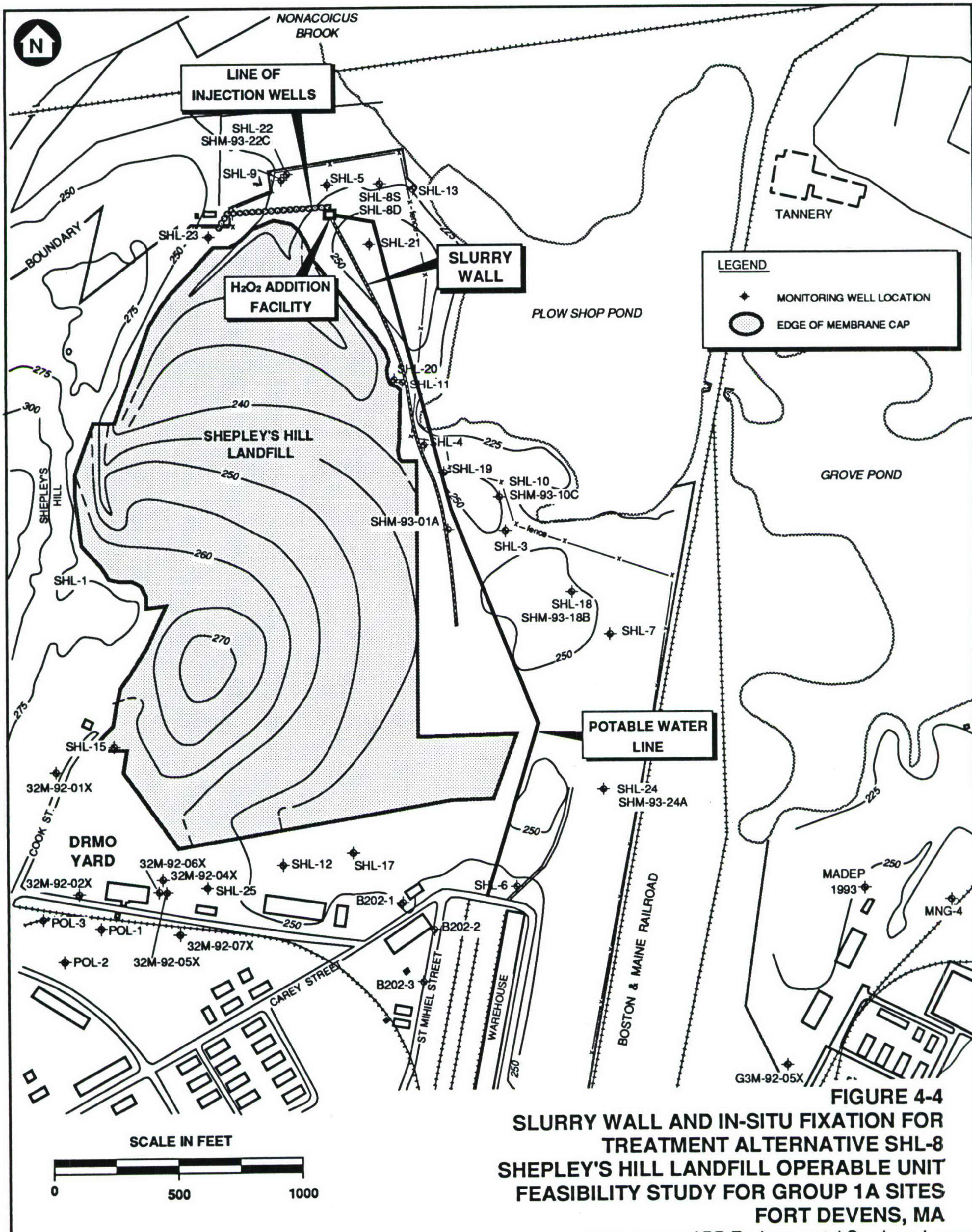
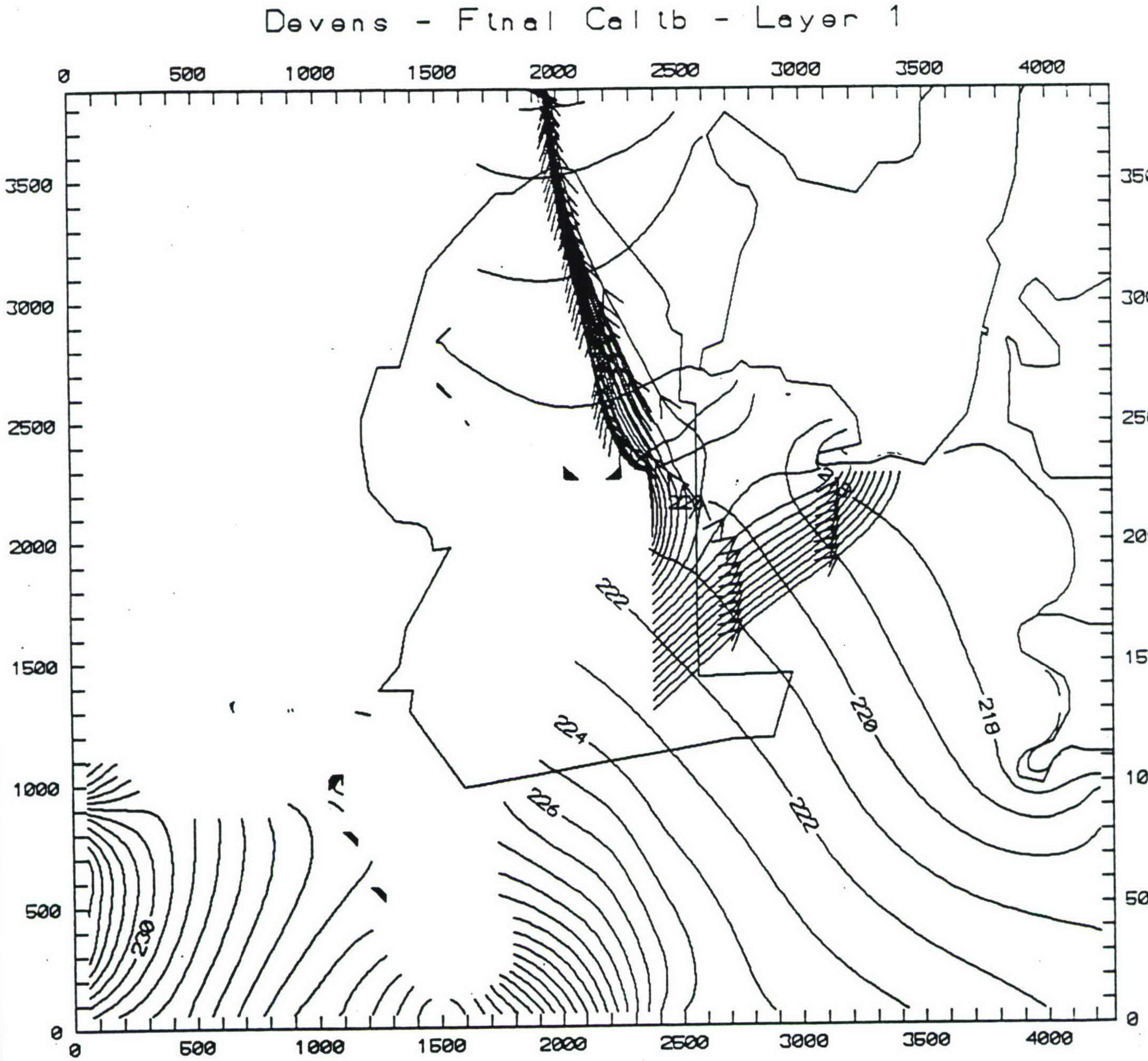


FIGURE 4-4
SLURRY WALL AND IN-SITU FIXATION FOR TREATMENT ALTERNATIVE SHL-8
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

9403007D 1 S6 G

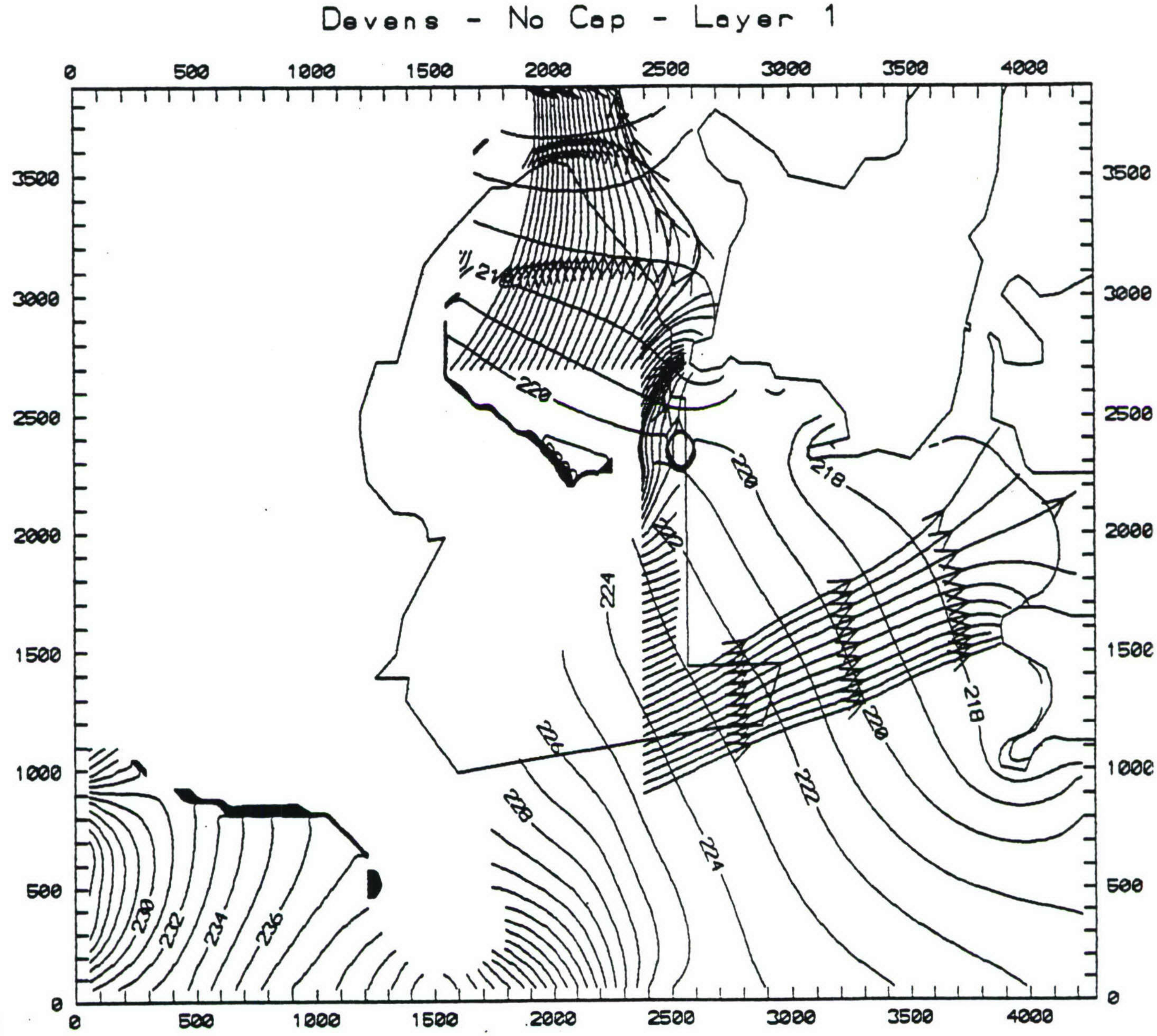


NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

SCALE IN FEET
0 500 1000

FIGURE 4-5
GROUNDWATER MODELING:
RUN IDENTIFICATION SS FINAL
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.



NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

FIGURE 4-6
GROUNDWATER MODELING:
RUN IDENTIFICATION NO CAP
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

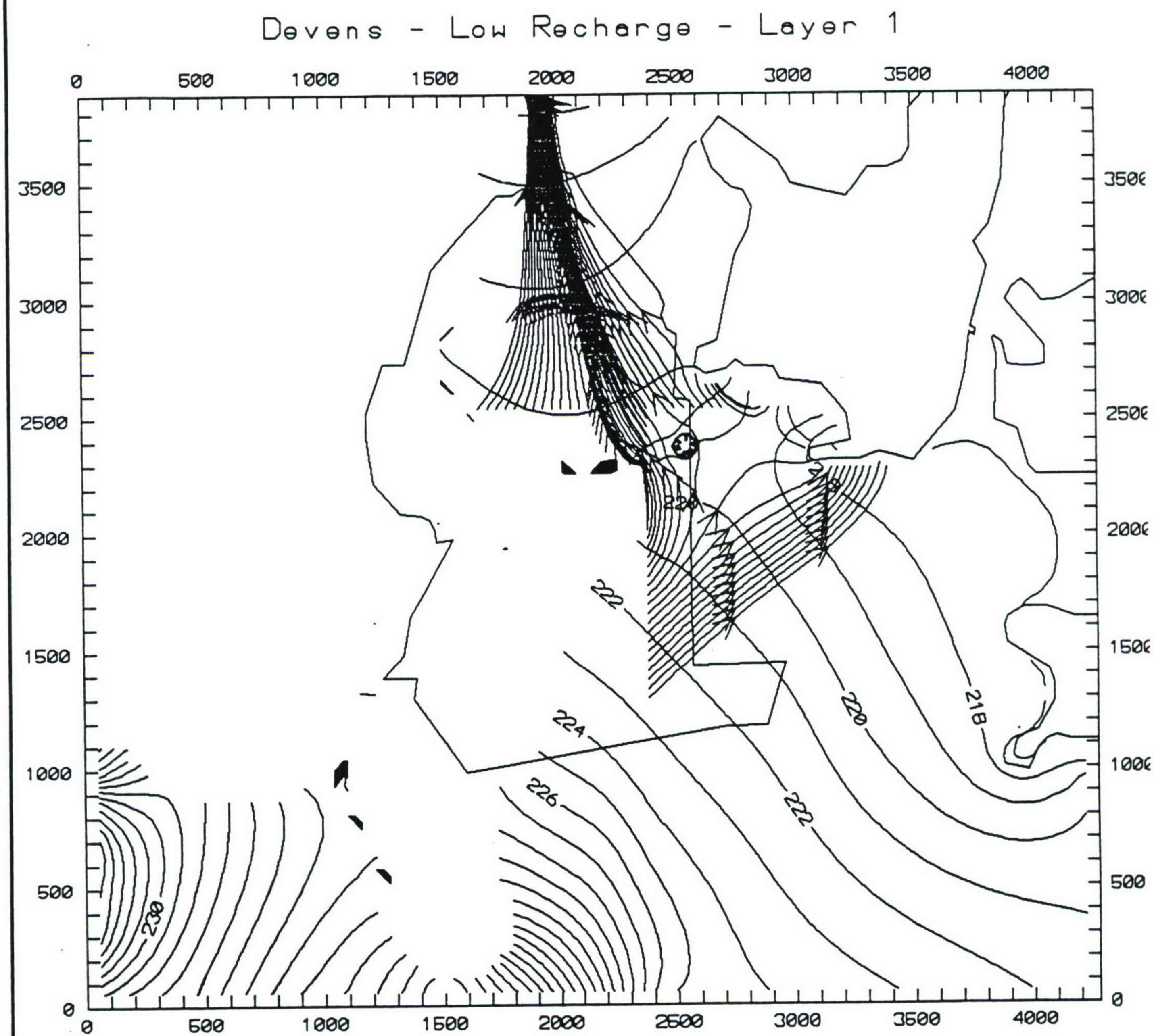


FIGURE 4-7
GROUNDWATER MODELING:
EFFECT OF LOW RECHARGE ON
GROUNDWATER ELEVATIONS
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

SCALE IN FEET
0 500 1000

ABB Environmental Services, Inc.

07005-12

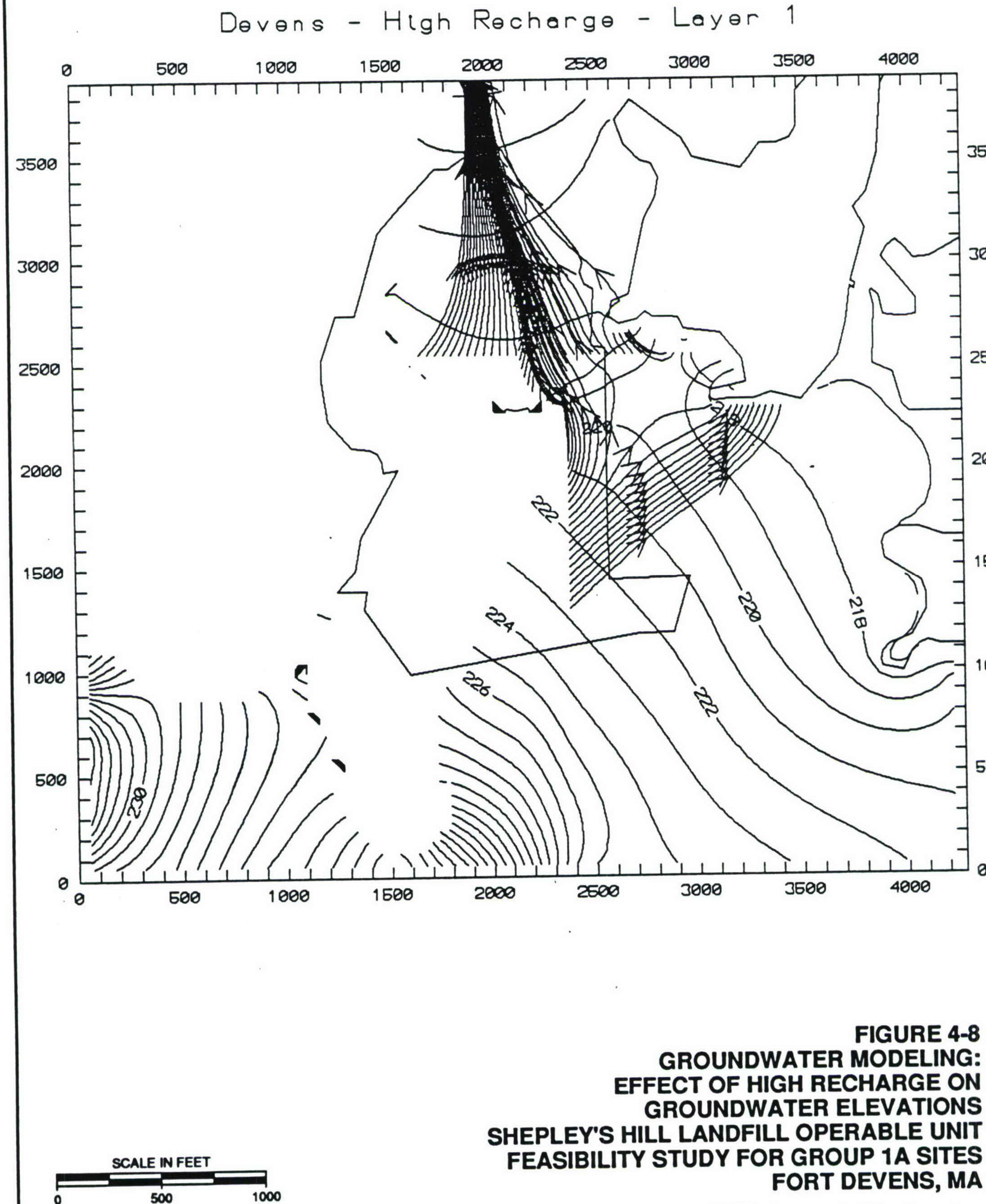


FIGURE 4-8
GROUNDWATER MODELING:
EFFECT OF HIGH RECHARGE ON
GROUNDWATER ELEVATIONS
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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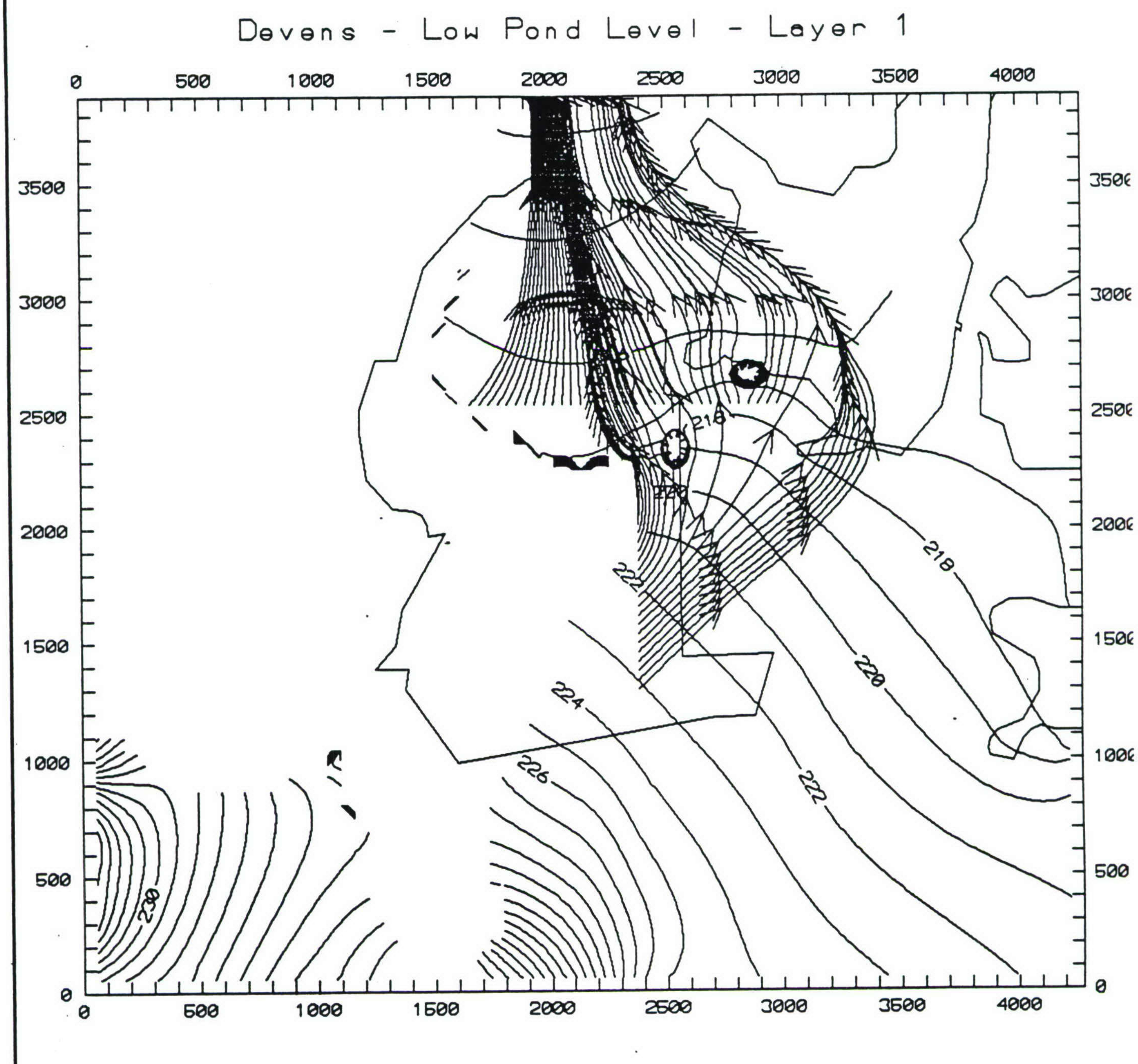

FIGURE 4-9
GROUNDWATER MODELING:
EFFECT OF LOW POND ELEVATION ON GROUNDWATER FLOW
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-12

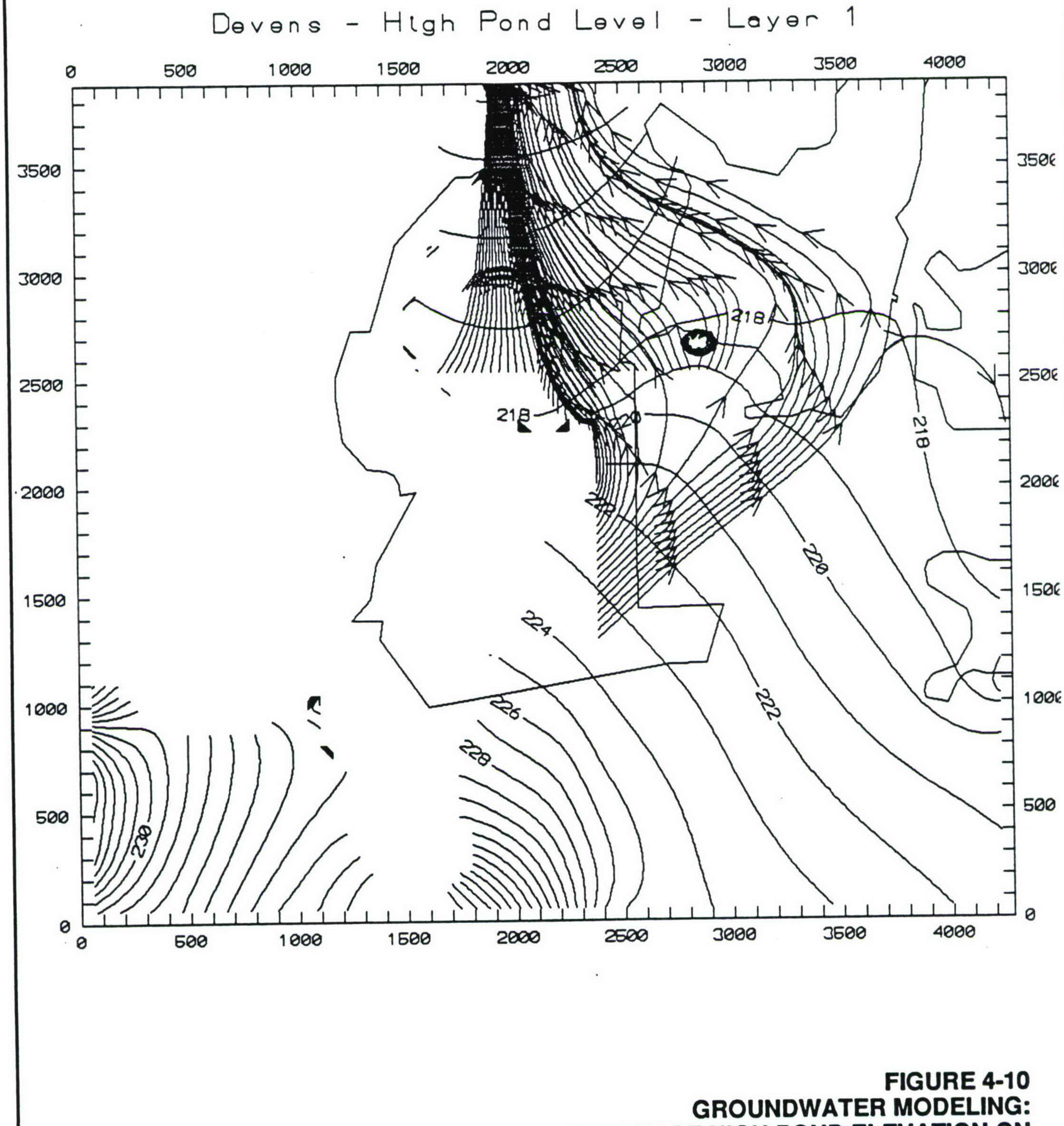

FIGURE 4-10
GROUNDWATER MODELING:
EFFECT OF HIGH POND ELEVATION ON GROUNDWATER FLOW
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-12

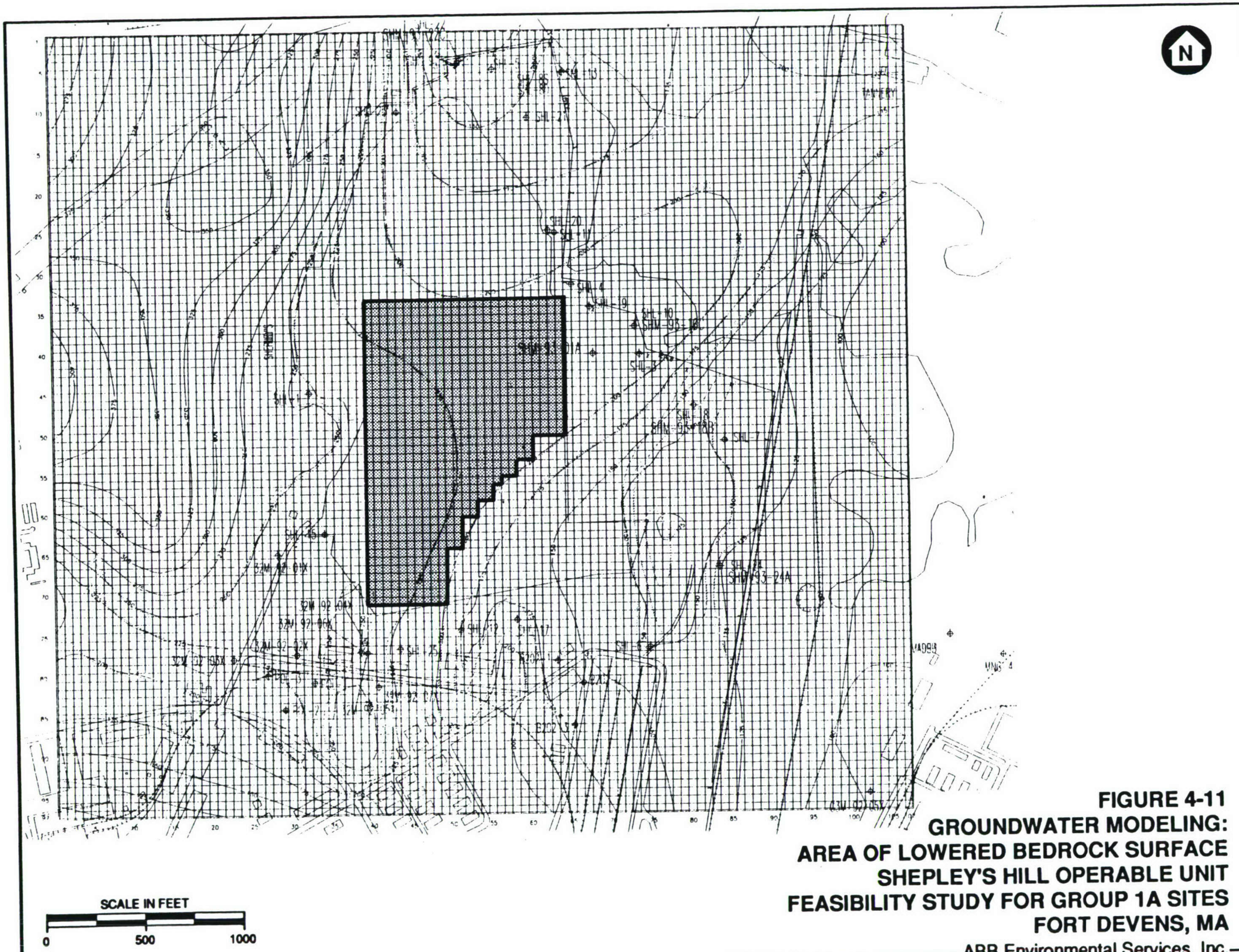

FIGURE 4-11
GROUNDWATER MODELING:
AREA OF LOWERED BEDROCK SURFACE
SHEPLEY'S HILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-12

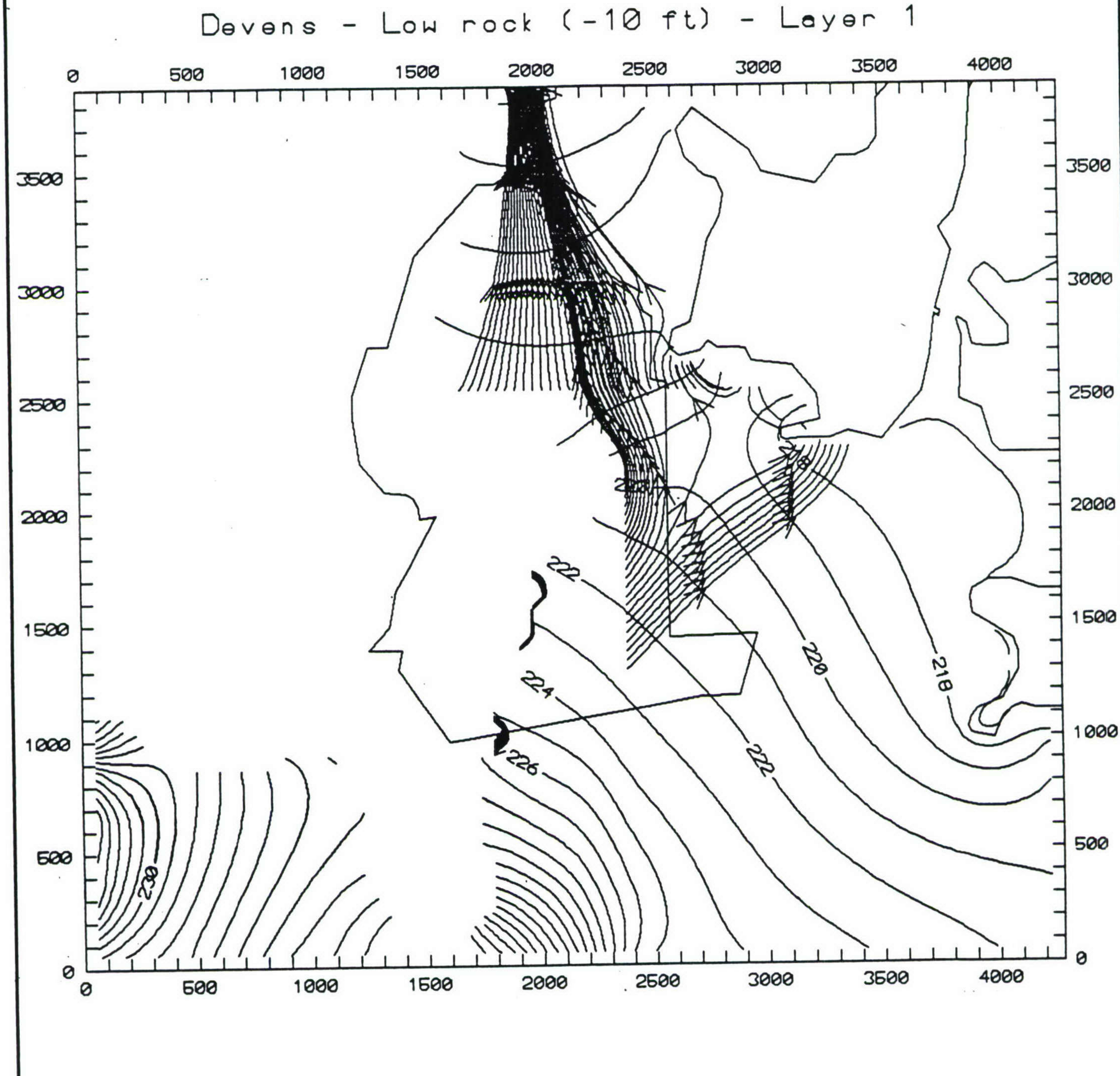

FIGURE 4-12
GROUNDWATER MODELING:
EFFECT OF LOWERING BEDROCK SURFACE
10 FEET - LAYER 1
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-12

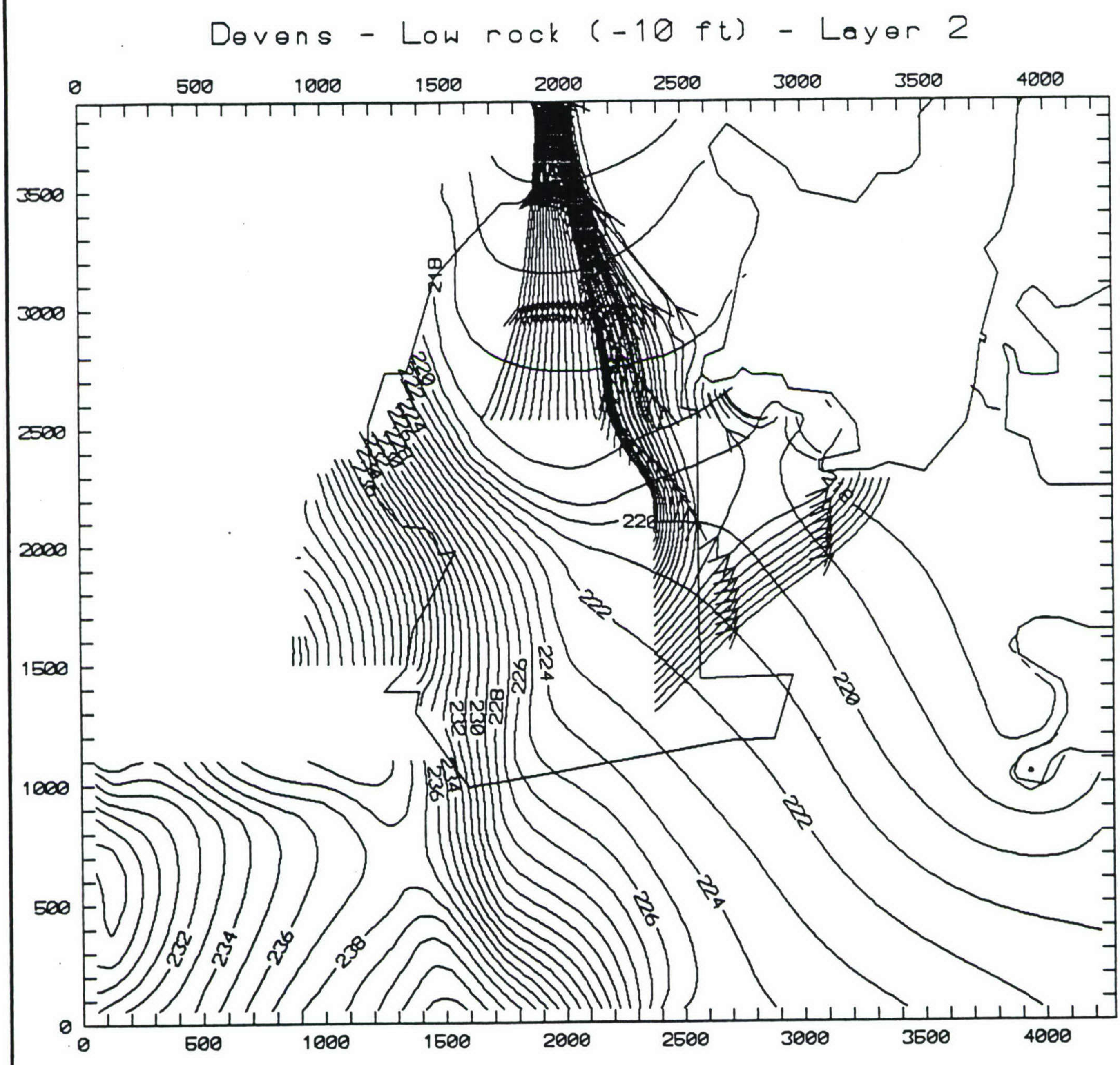

FIGURE 4-13
GROUNDWATER MODELING:
EFFECT OF LOWERING BEDROCK SURFACE
10 FEET - LAYER 2
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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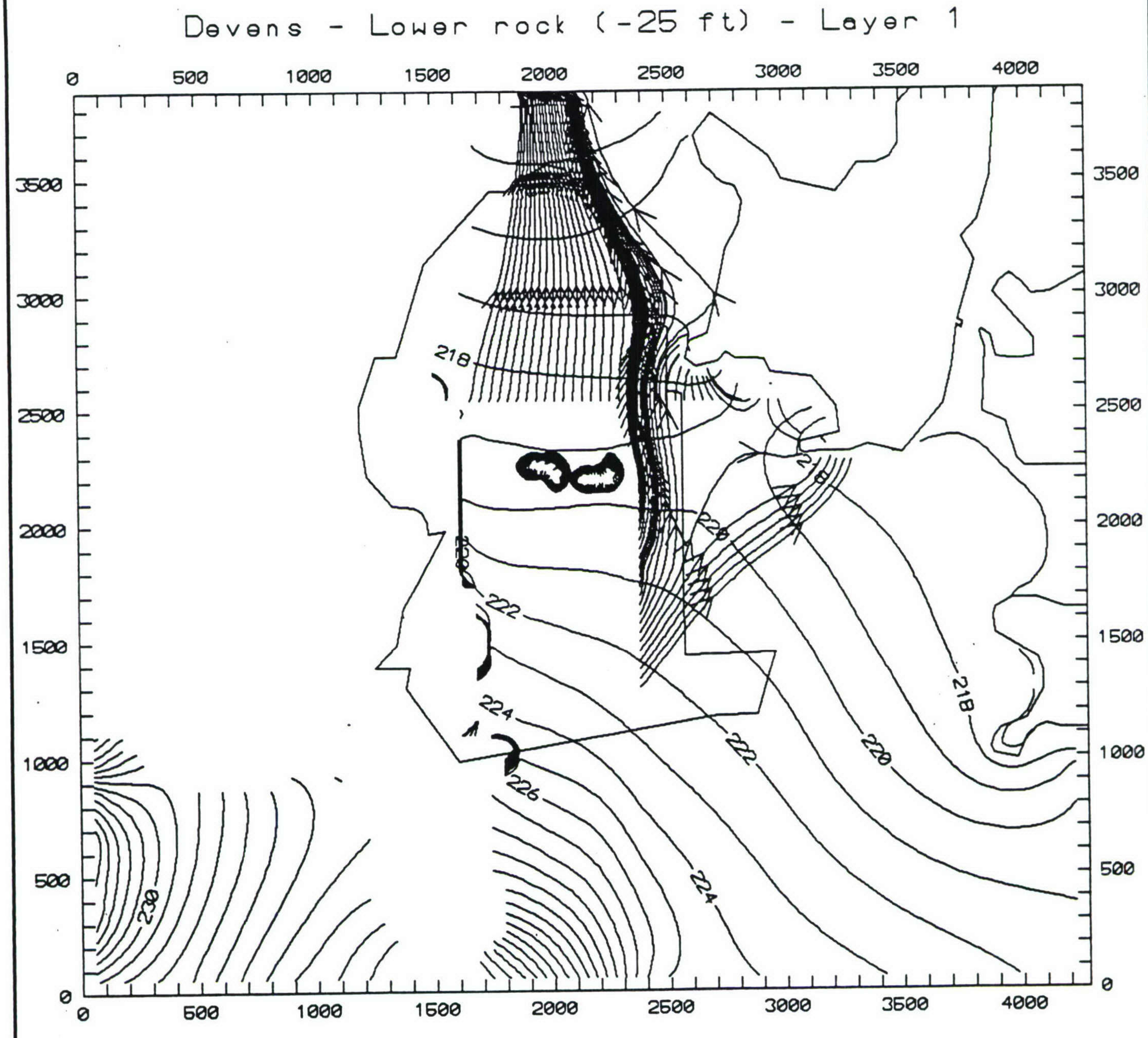


FIGURE 4-14
GROUNDWATER MODELING:
EFFECT OF LOWERING BEDROCK SURFACE
25 FEET - LAYER 1
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

SCALE IN FEET
0 500 1000

ABB Environmental Services, Inc.

07005-12

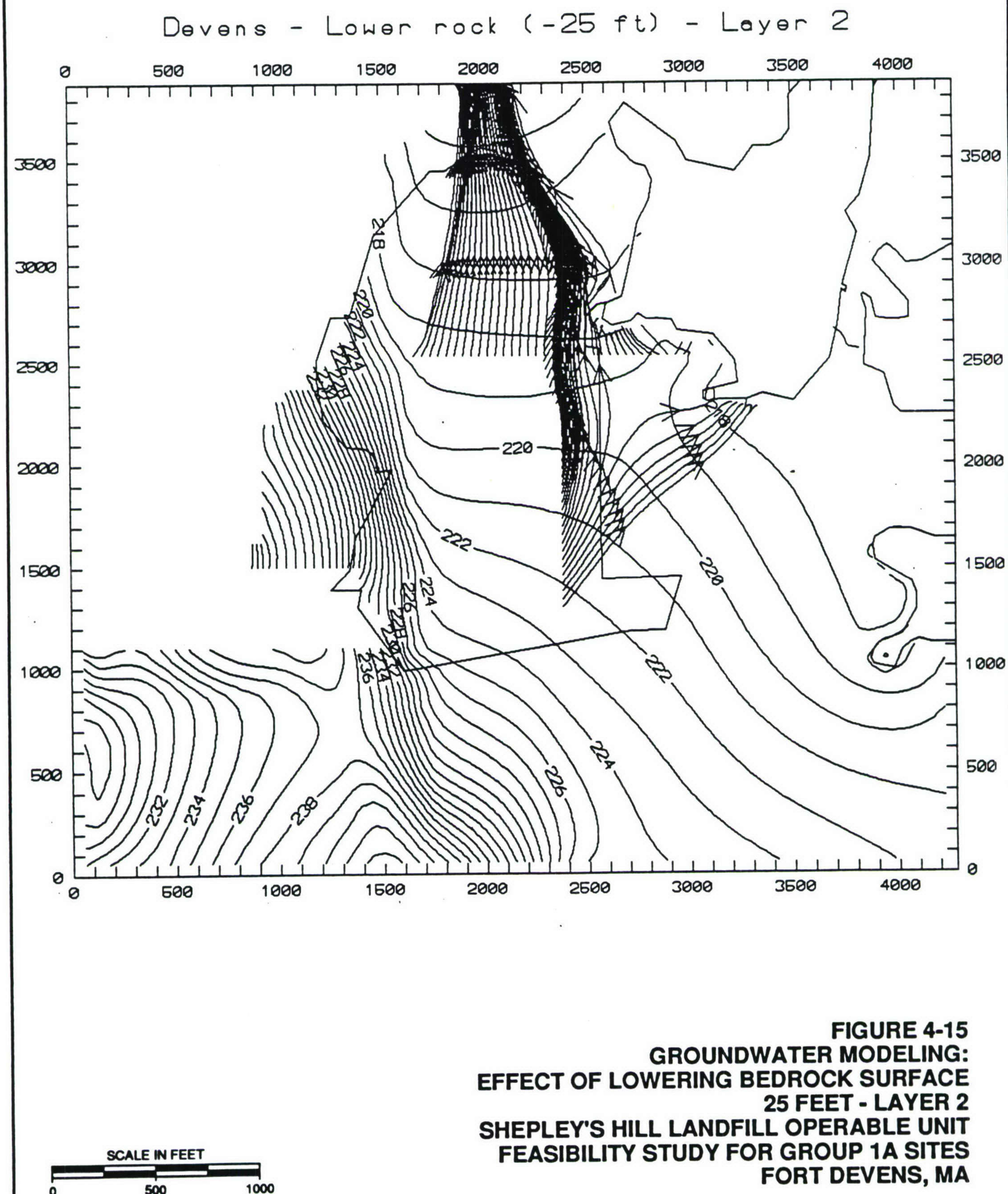
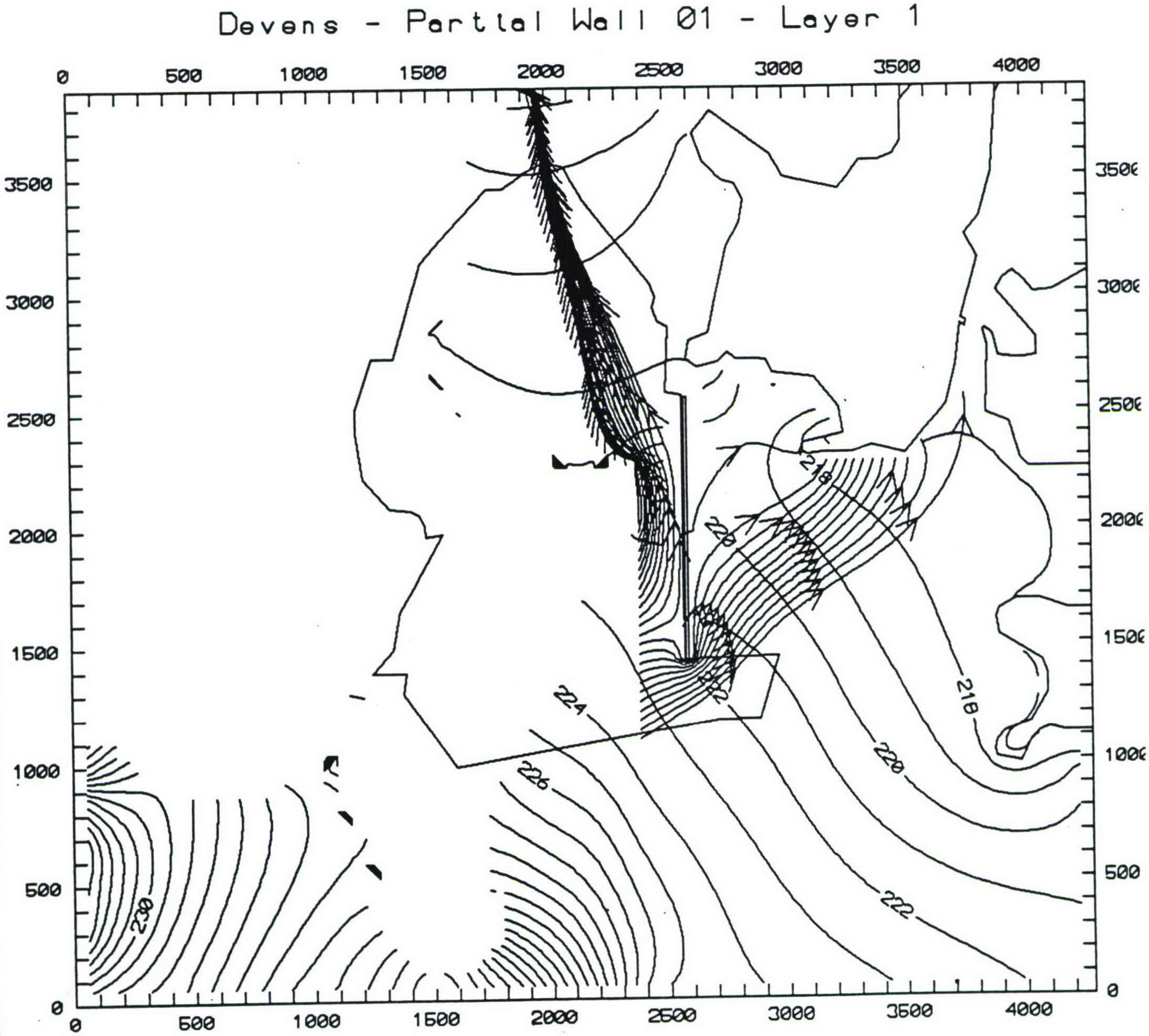


FIGURE 4-15
GROUNDWATER MODELING:
EFFECT OF LOWERING BEDROCK SURFACE
25 FEET - LAYER 2
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

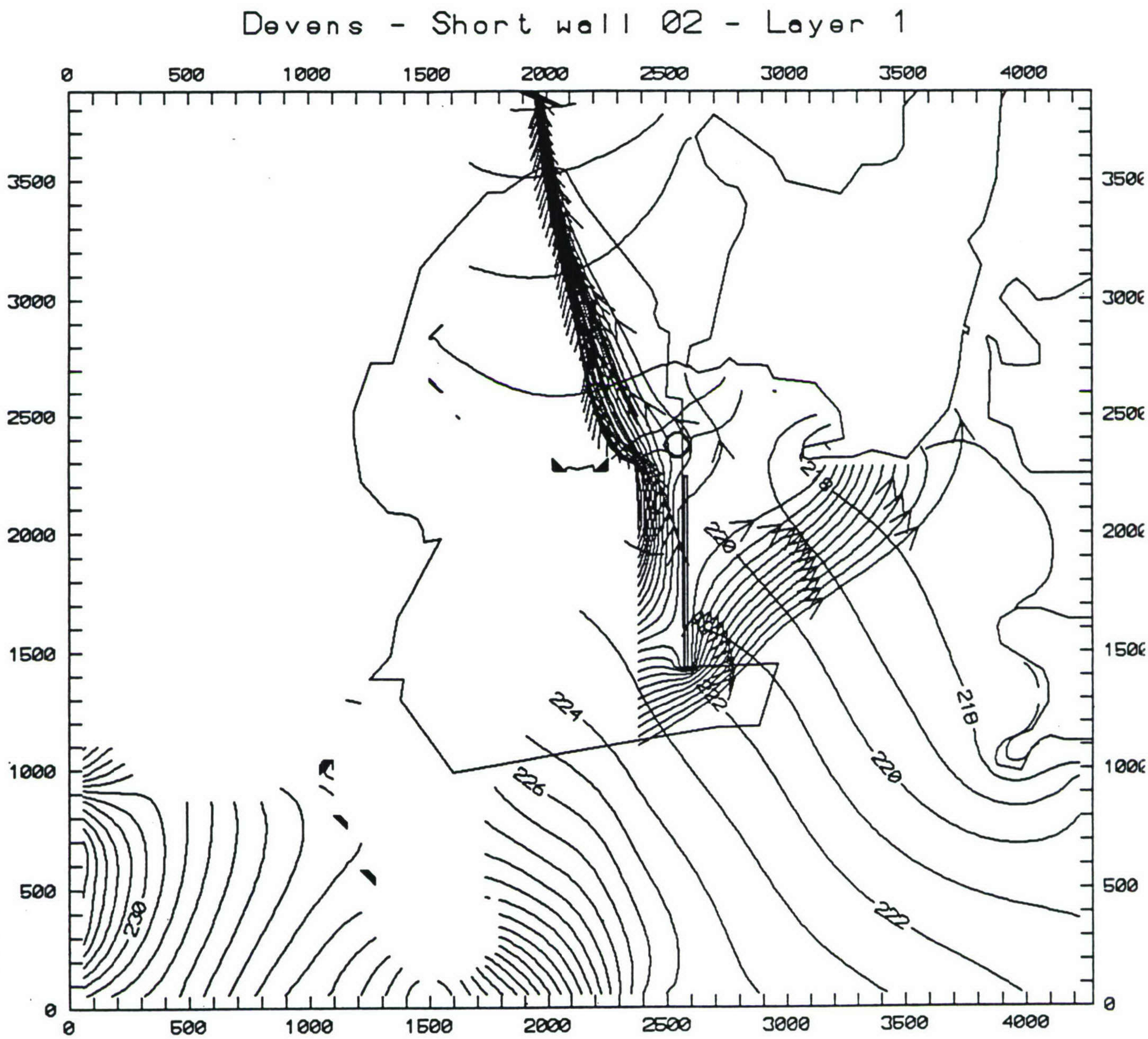
ABB Environmental Services, Inc.

07005-12



NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

FIGURE 4-16
GROUNDWATER MODELING:
RUN IDENTIFICATION PWALL 01
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

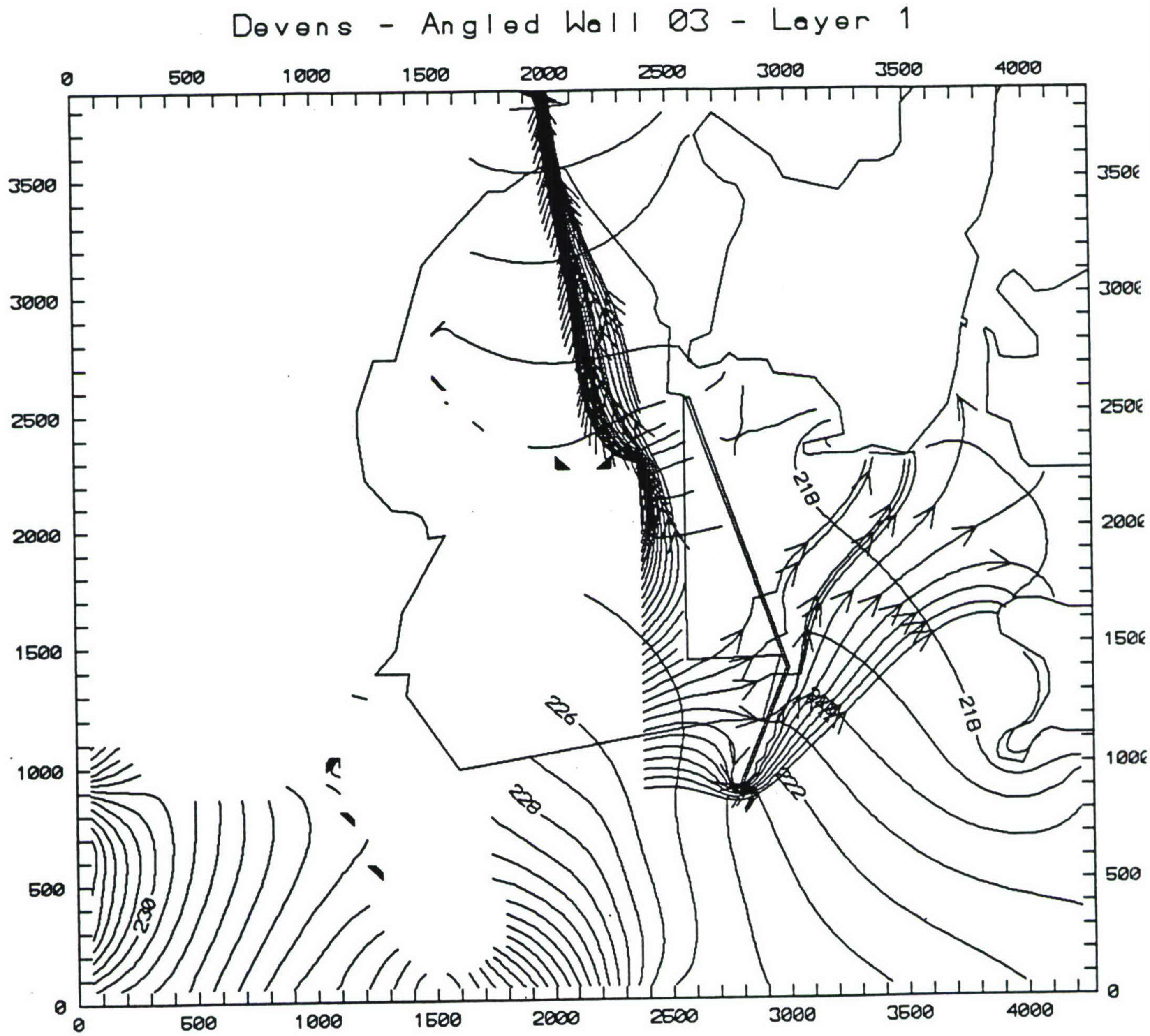


NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

FIGURE 4-17
GROUNDWATER MODELING:
RUN IDENTIFICATION PWALL 02
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

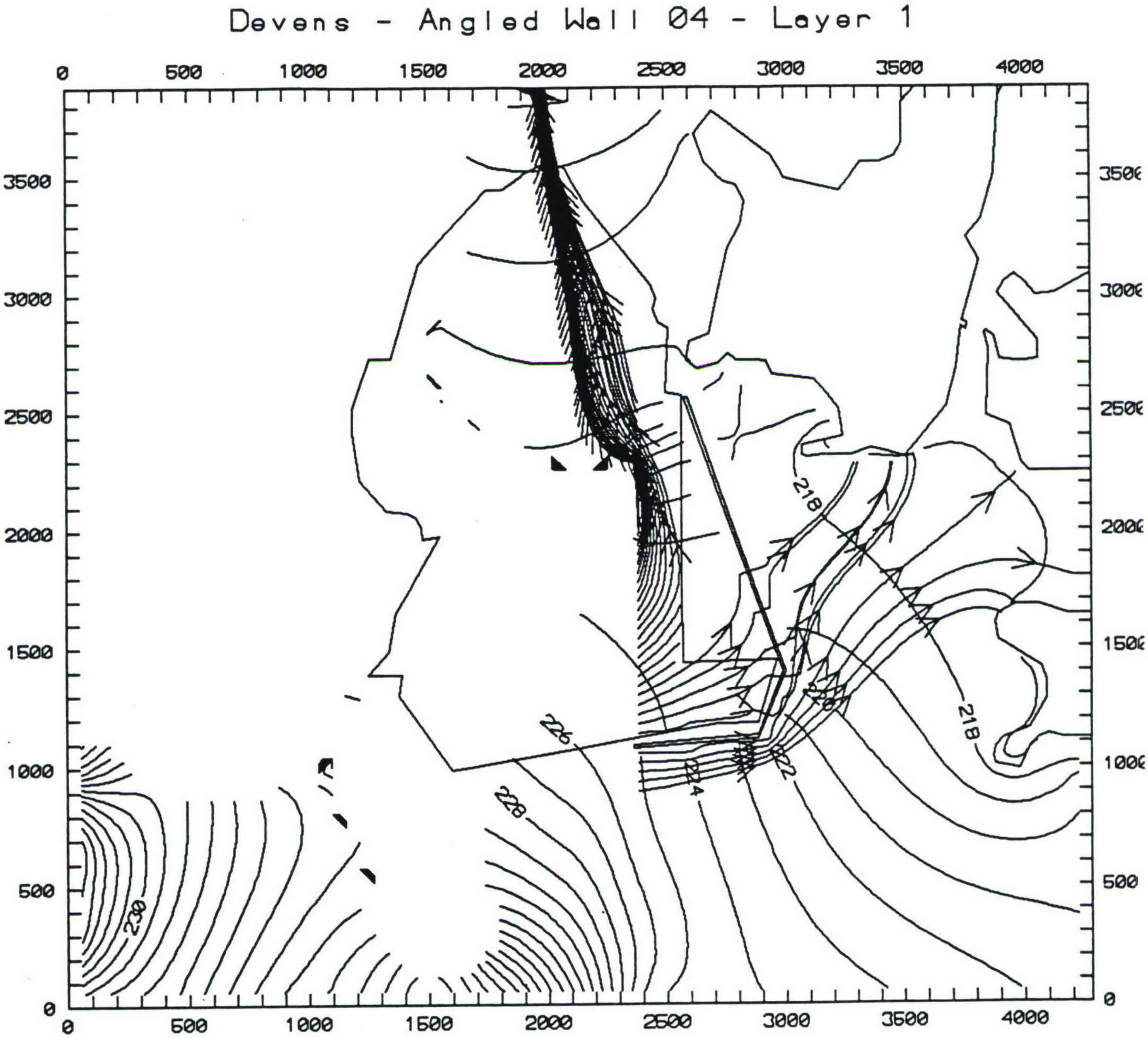
07005-04



NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

FIGURE 4-18
GROUNDWATER MODELING:
RUN IDENTIFICATION PWALL 03
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.



NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

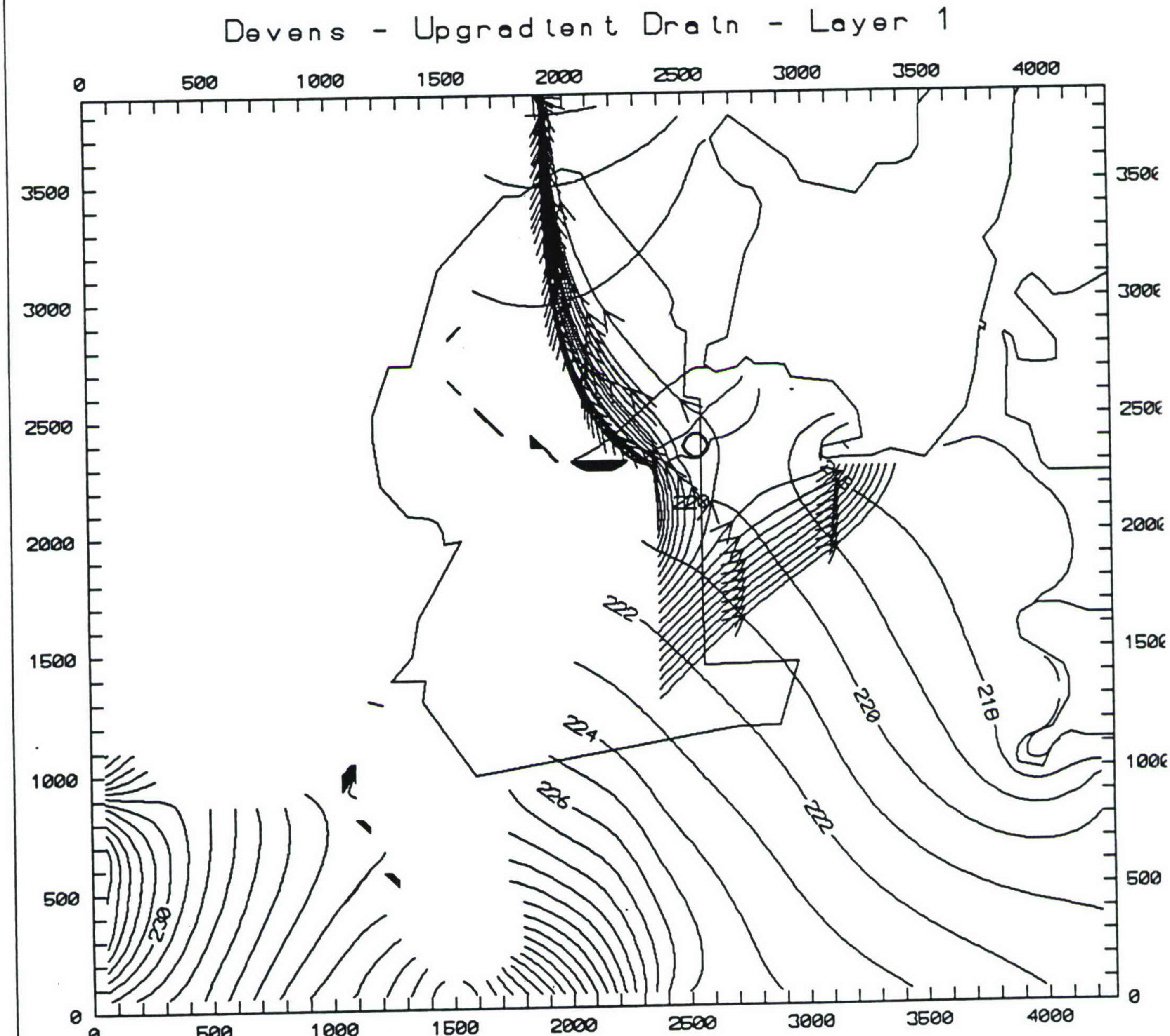
SCALE IN FEET

0 500 1000

FIGURE 4-19
GROUNDWATER MODELING:
RUN IDENTIFICATION PWALL 04
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-04



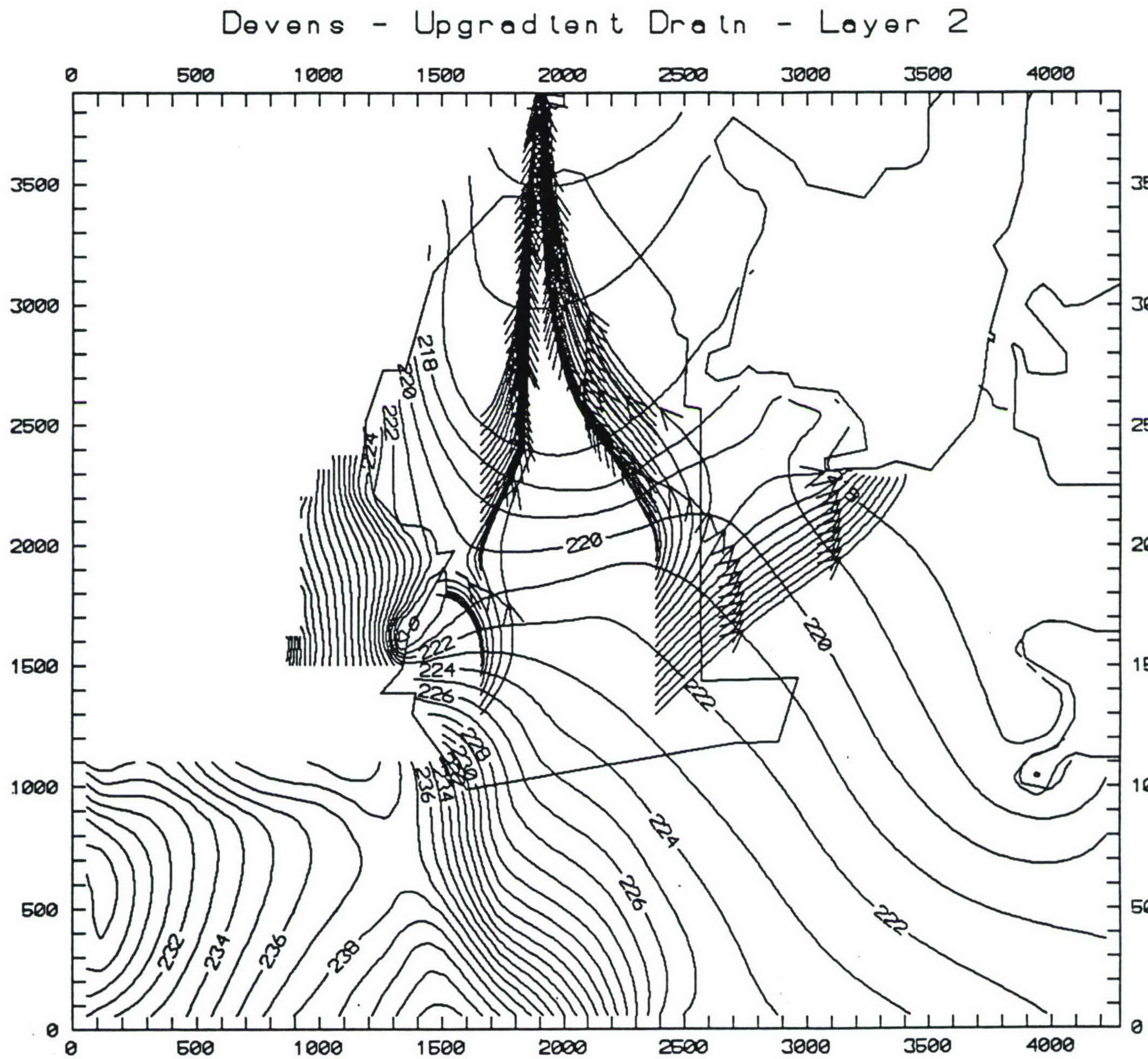
NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

SCALE IN FEET
0 500 1000

FIGURE 4-20
GROUNDWATER MODELING:
RUN IDENTIFICATION DRAIN - LAYER 1
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-04



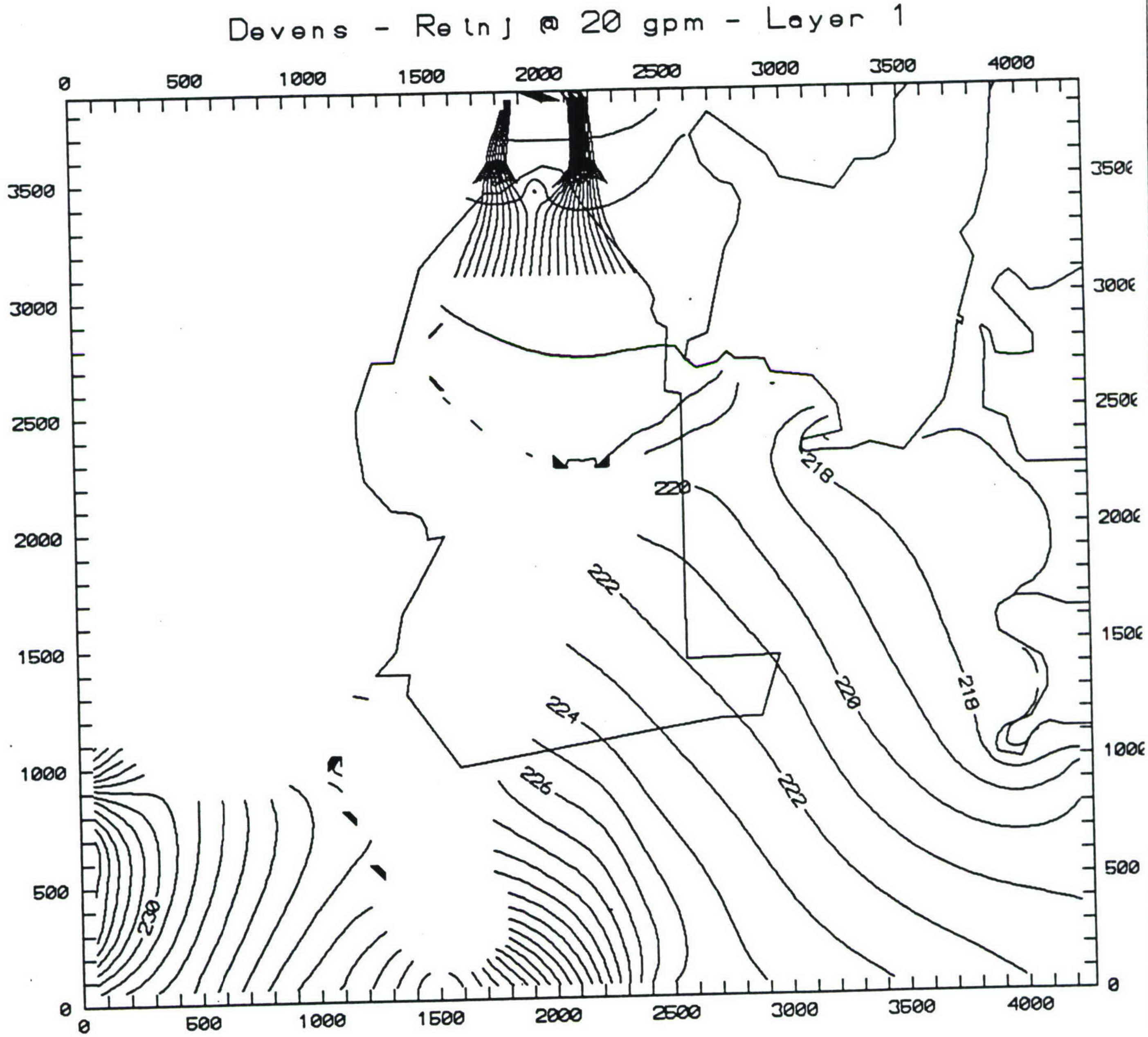
NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

SCALE IN FEET
0 500 1000

FIGURE 4-21
GROUNDWATER MODELING:
RUN IDENTIFICATION DRAIN - LAYER 2
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-04



NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

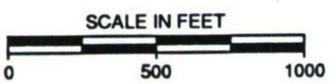
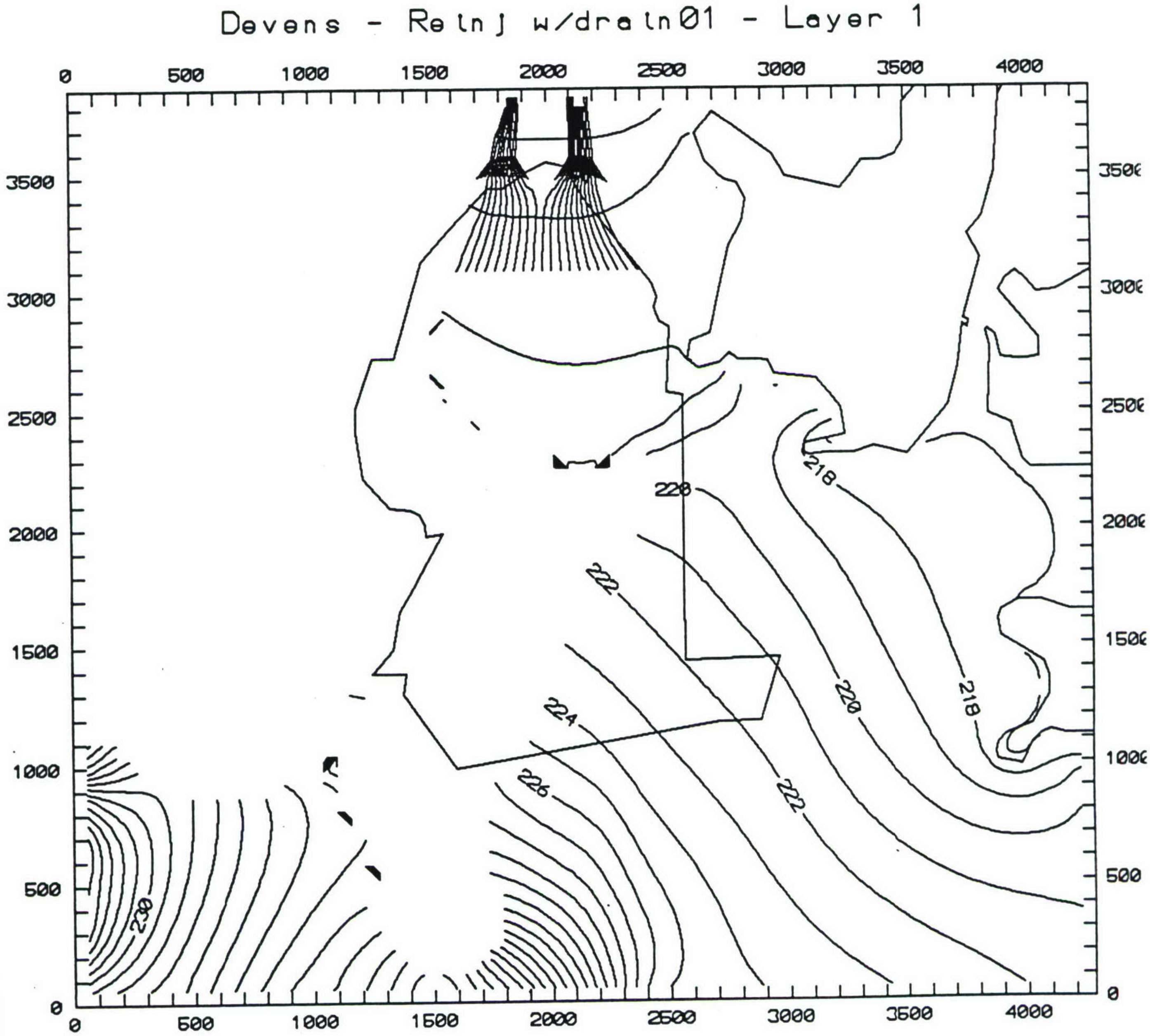


FIGURE 4-22
GROUNDWATER MODELING:
RUN IDENTIFICATION REINJ 01
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-04



NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

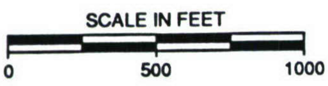
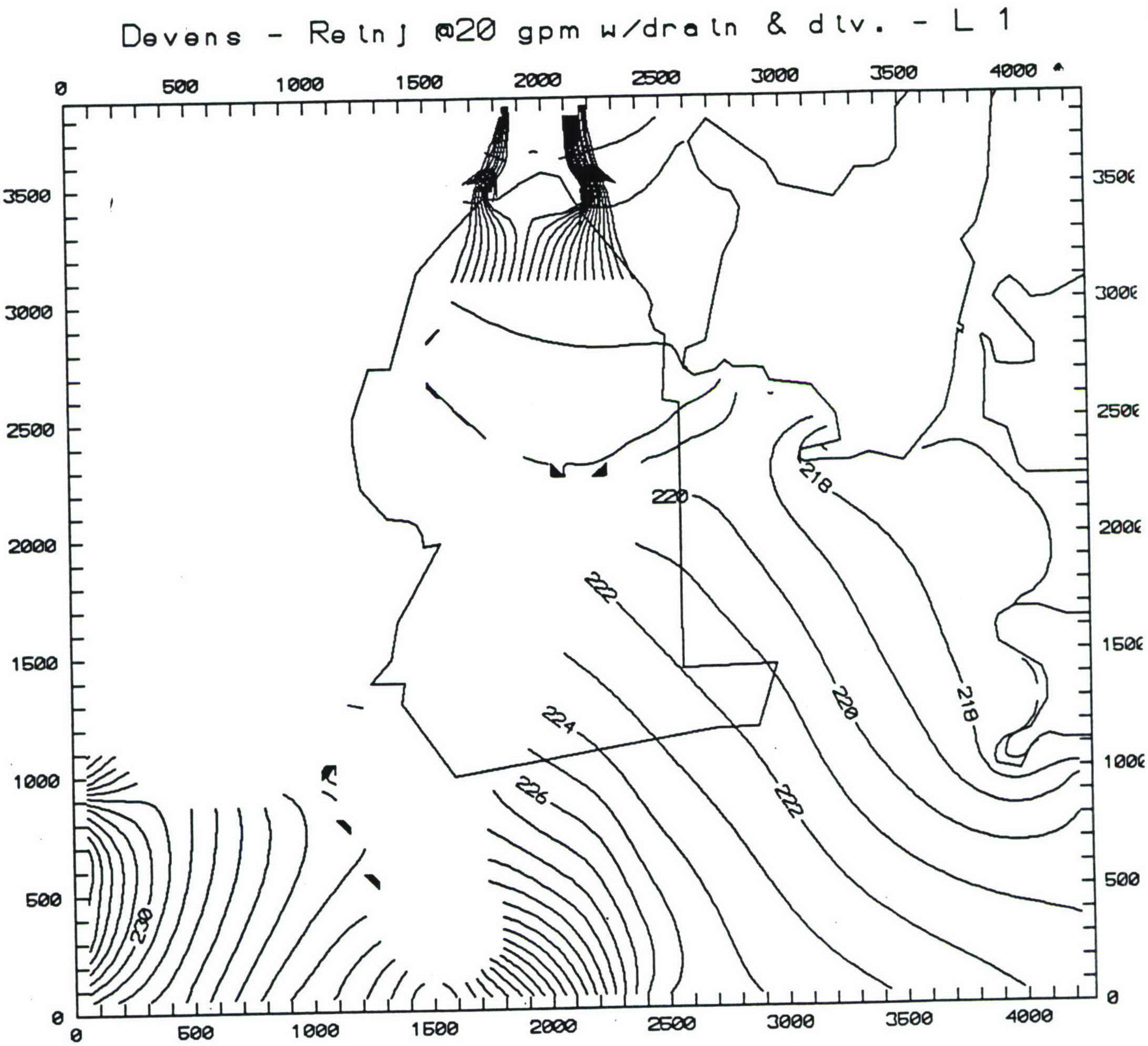


FIGURE 4-23
GROUNDWATER MODELING:
RUN IDENTIFICATION DRAIN 1
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-04



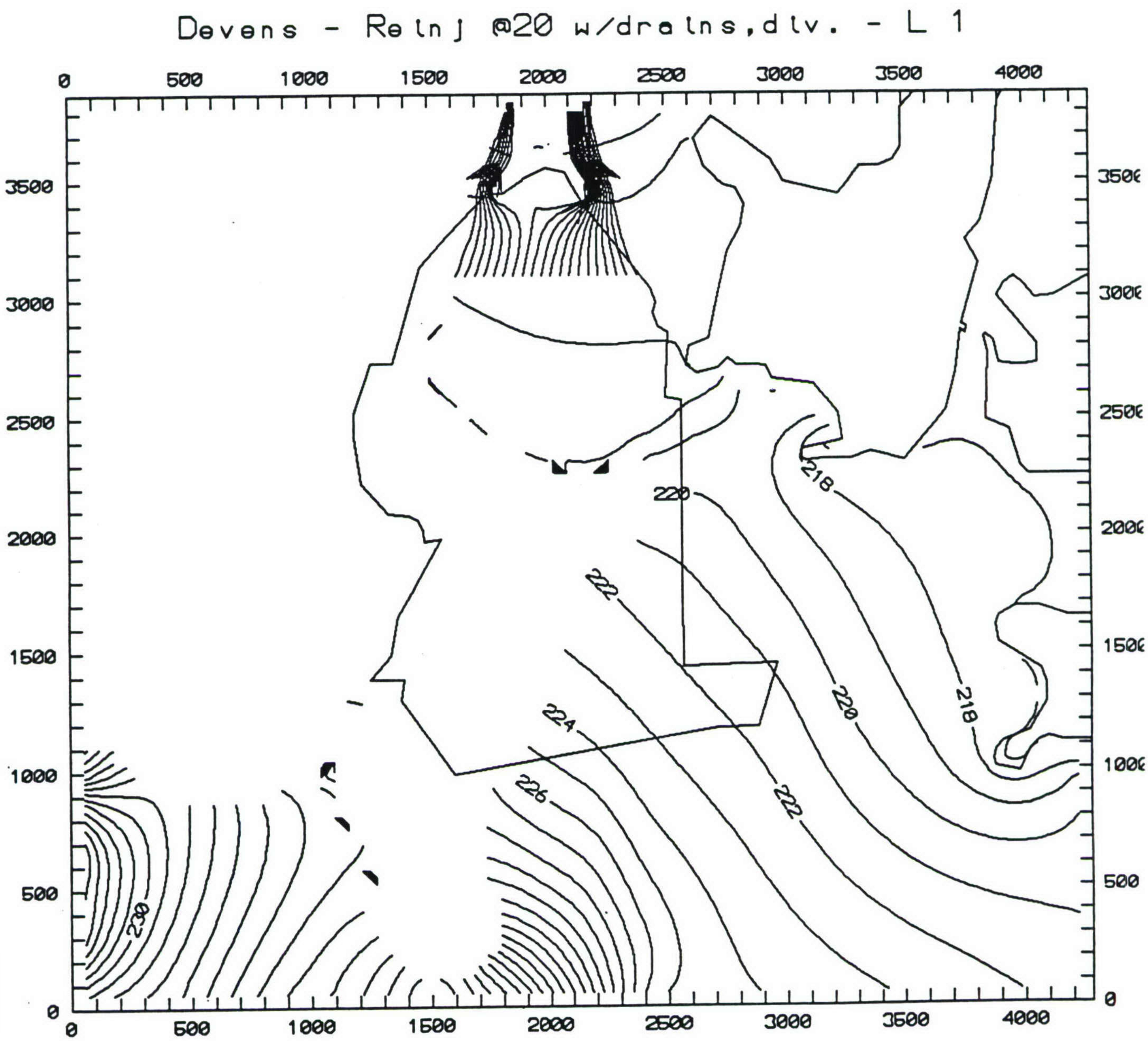
NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

SCALE IN FEET
0 500 1000

FIGURE 4-24
GROUNDWATER MODELING:
RUN IDENTIFICATION DRAIN 2
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-04



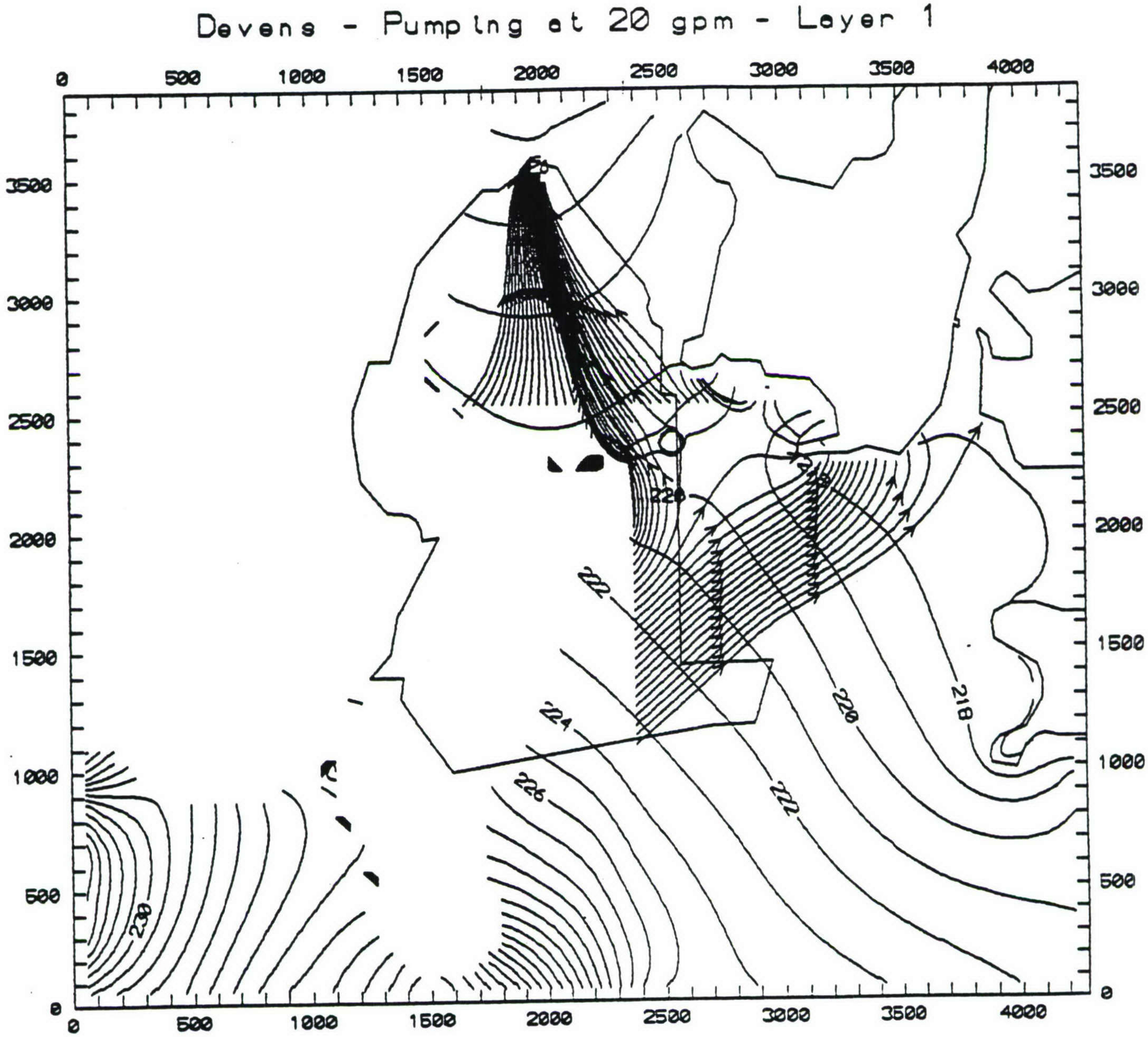
NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

FIGURE 4-25
GROUNDWATER MODELING:
RUN IDENTIFICATION DRAIN 3
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

SCALE IN FEET
0 500 1000

ABB Environmental Services, Inc.

07005-04



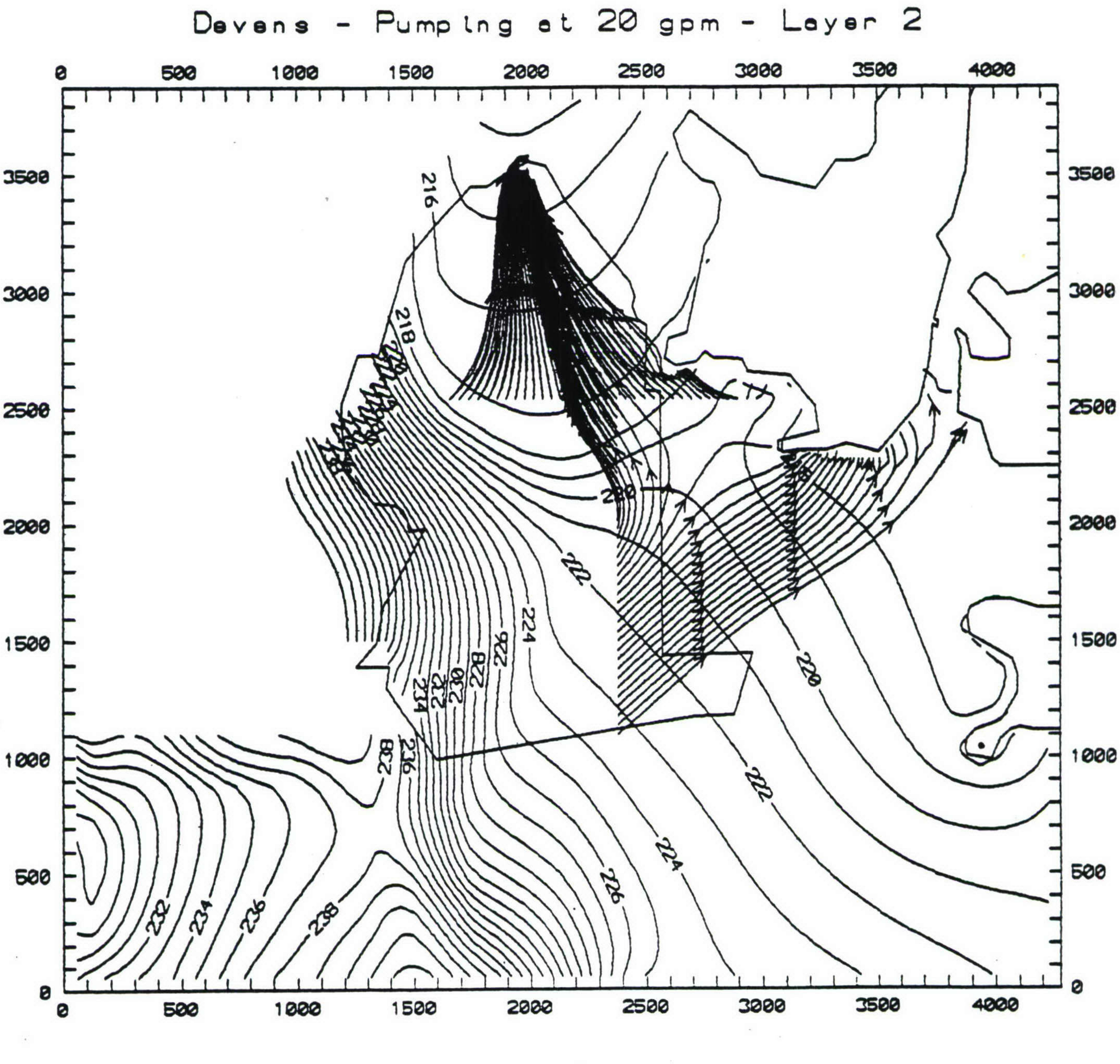
NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

SCALE IN FEET
0 500 1000

FIGURE 4-26
GROUNDWATER MODELING:
RUN IDENTIFICATION PUMP 01 - LAYER 1
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

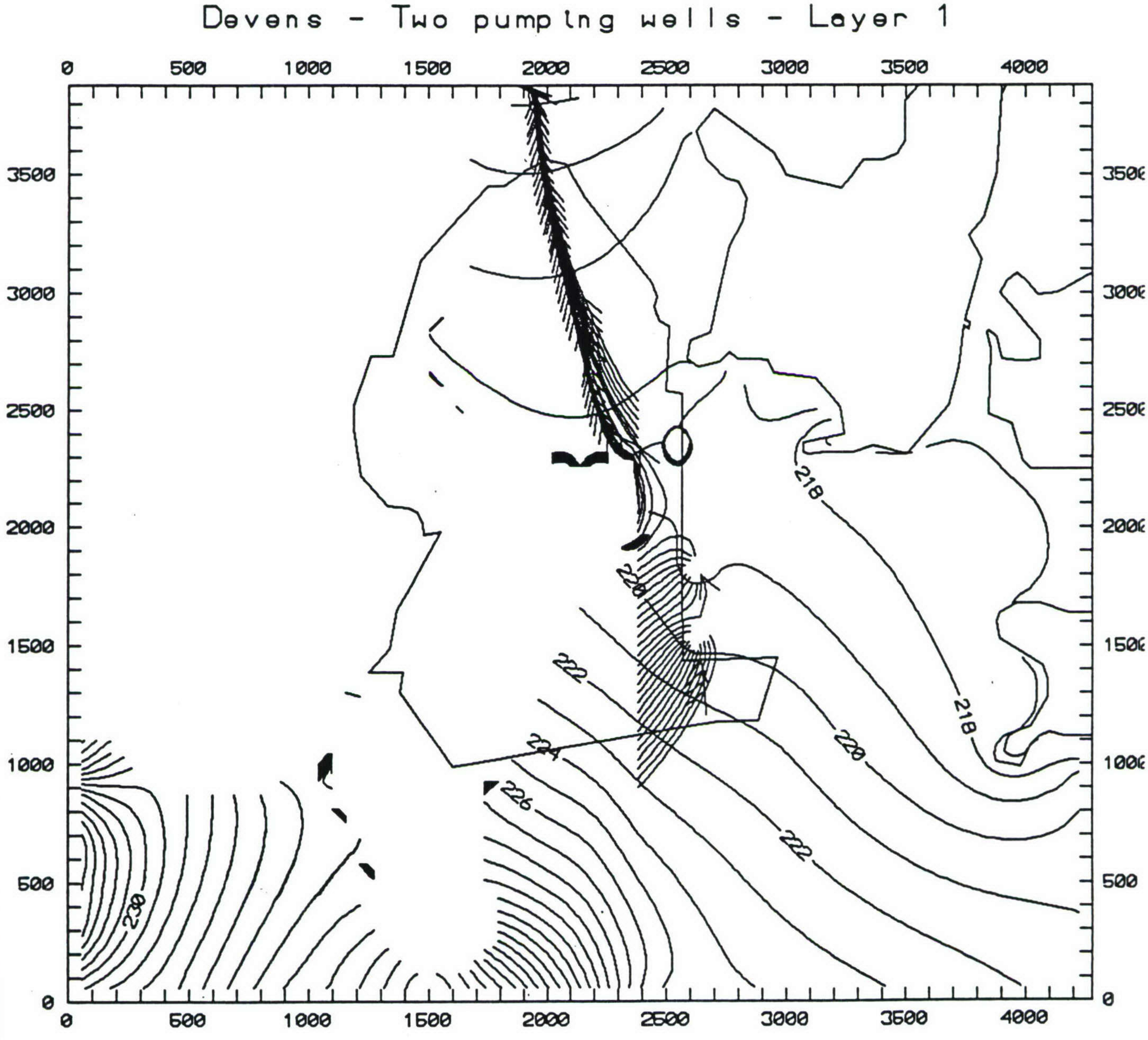
07005-04



NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

FIGURE 4-27
GROUNDWATER MODELING:
RUN IDENTIFICATION PUMP 02 - LAYER 2
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

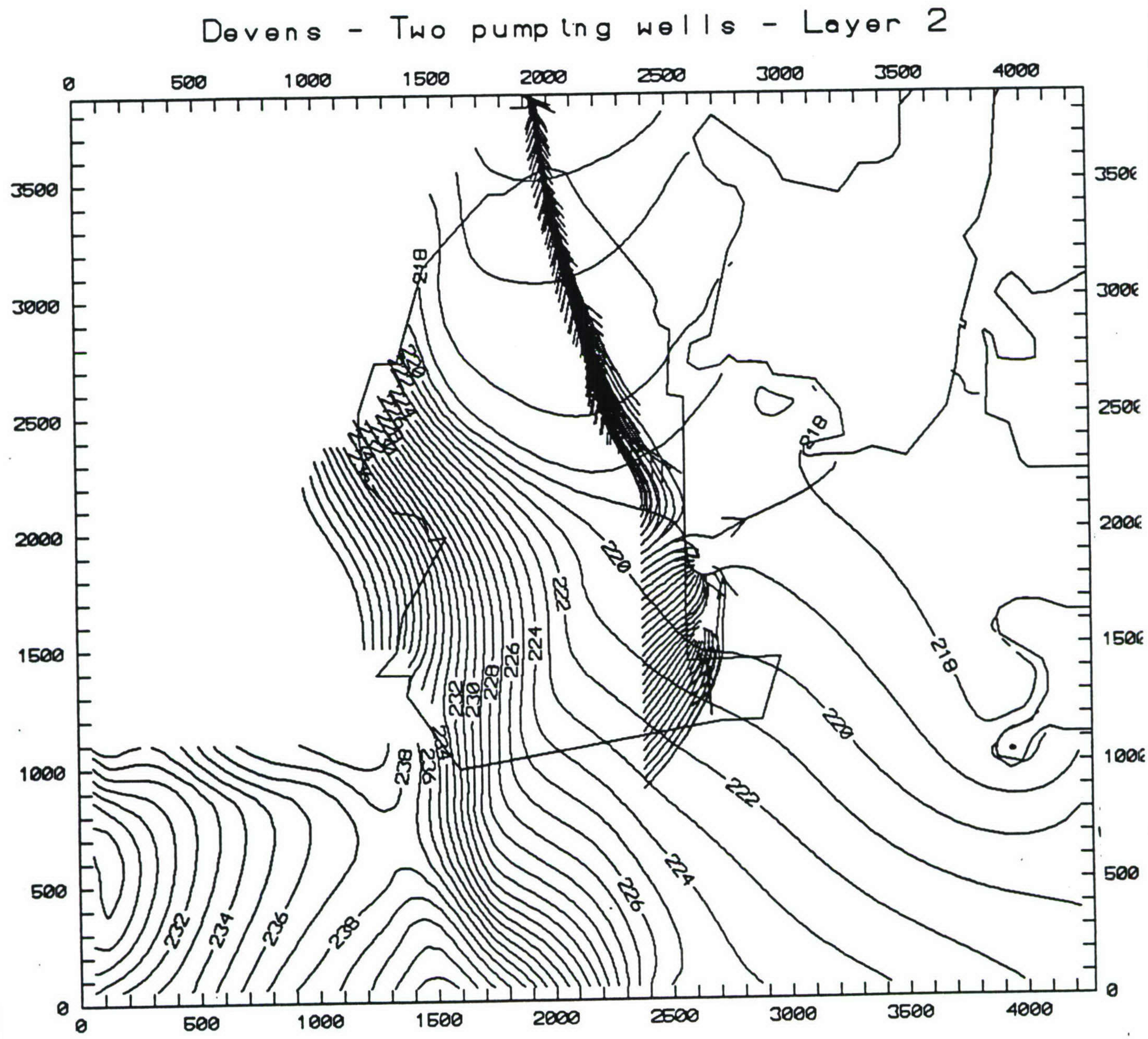


NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

FIGURE 4-28
GROUNDWATER MODELING:
RUN IDENTIFICATION PUMP 05 - LAYER 1
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

07005-04



NOTE: REFERENCE TABLE 4-2 FOR RUN IDENTIFICATION DESCRIPTION.

FIGURE 4-29
GROUNDWATER MODELING:
RUN IDENTIFICATION PUMP 05 - LAYER 2
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

SCALE IN FEET
0 500 1000

ABB Environmental Services, Inc.

07005-12

SECTION 5.0

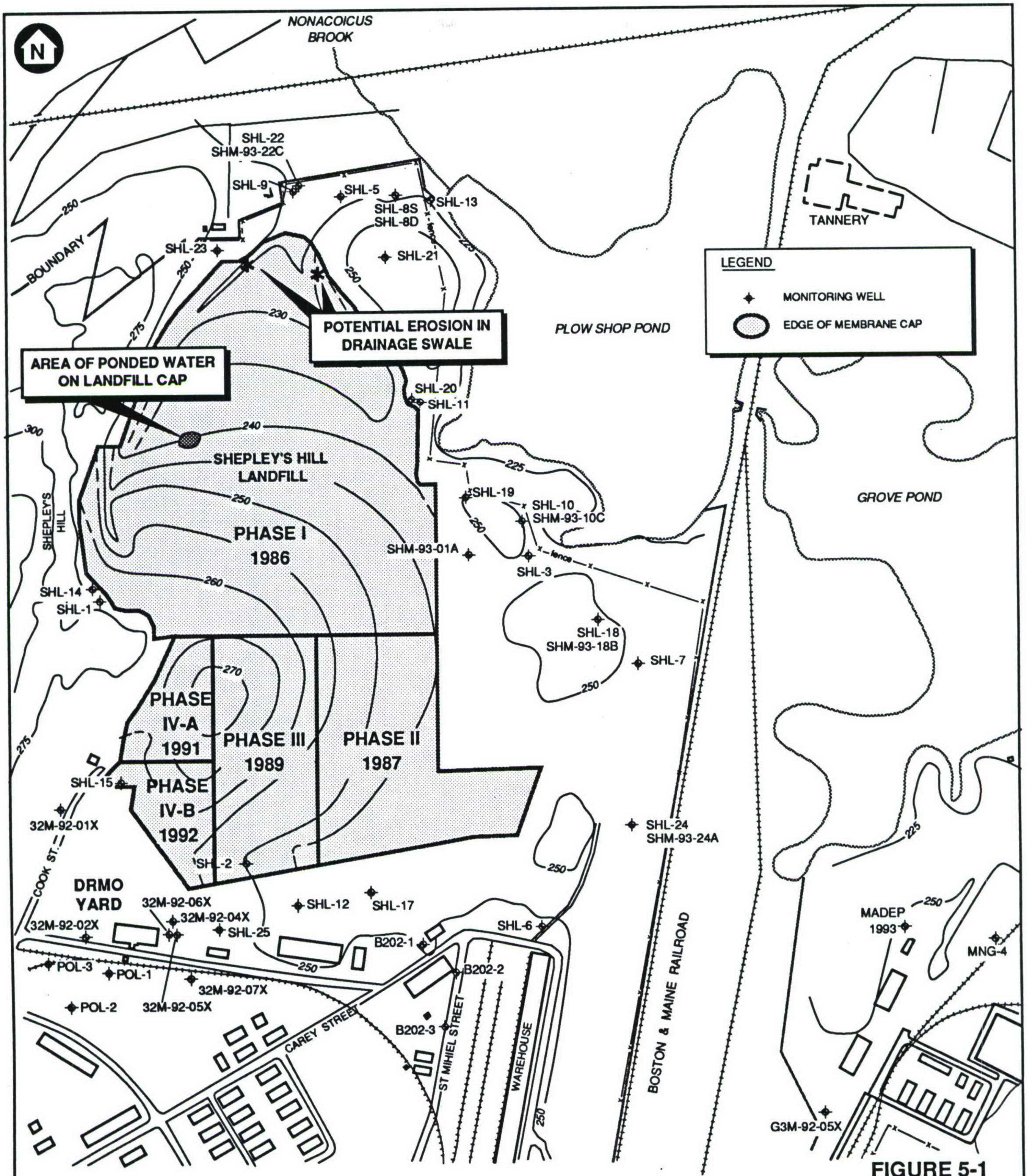


FIGURE 5-1
ALTERNATIVE SHL-2: LIMITED ACTION
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

9402037D 1 S6 M

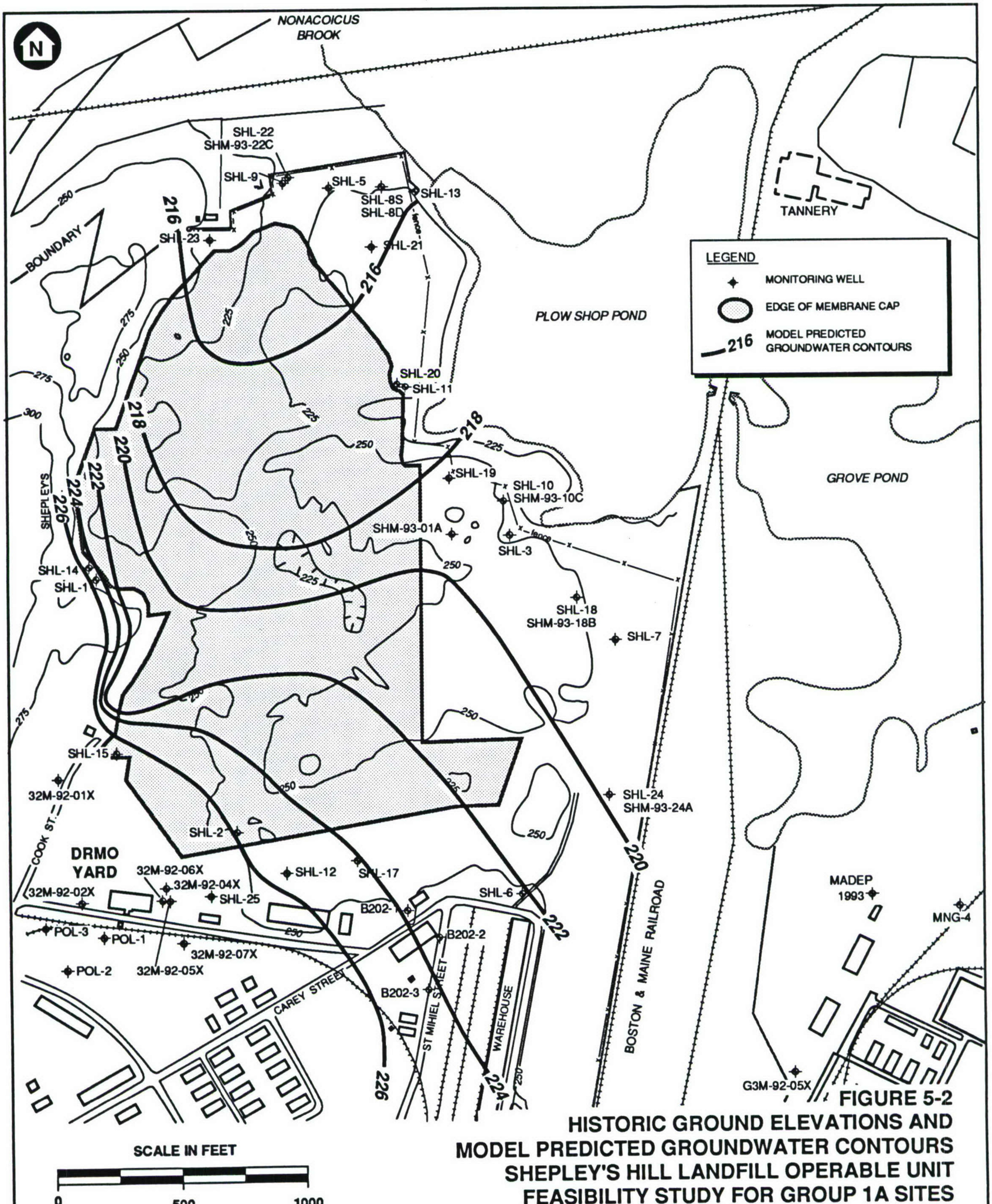


FIGURE 5-2
HISTORIC GROUND ELEVATIONS AND MODEL PREDICTED GROUNDWATER CONTOURS
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

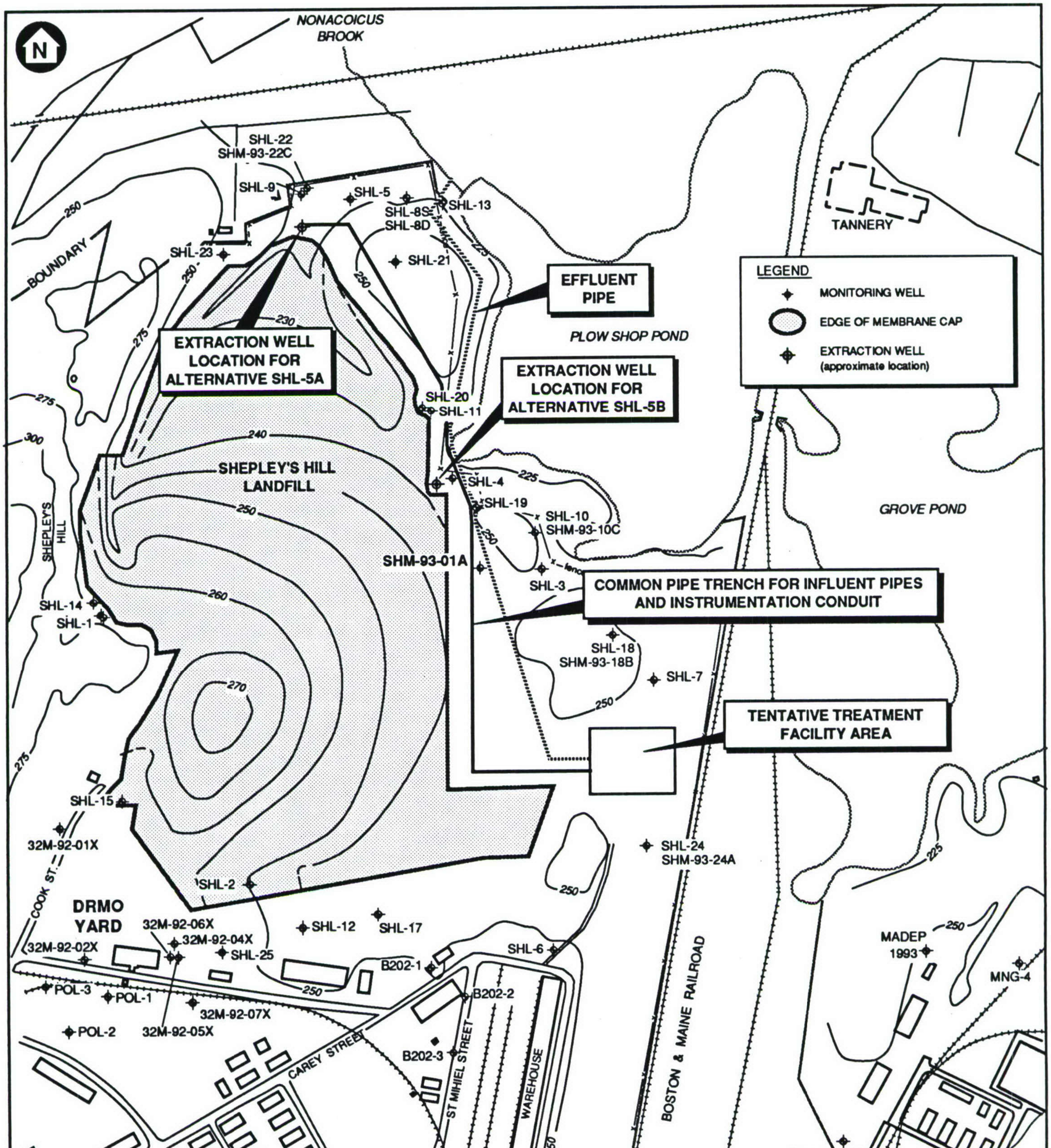


FIGURE 5-3
ALTERNATIVES SHL-5A AND SHL-5B:
COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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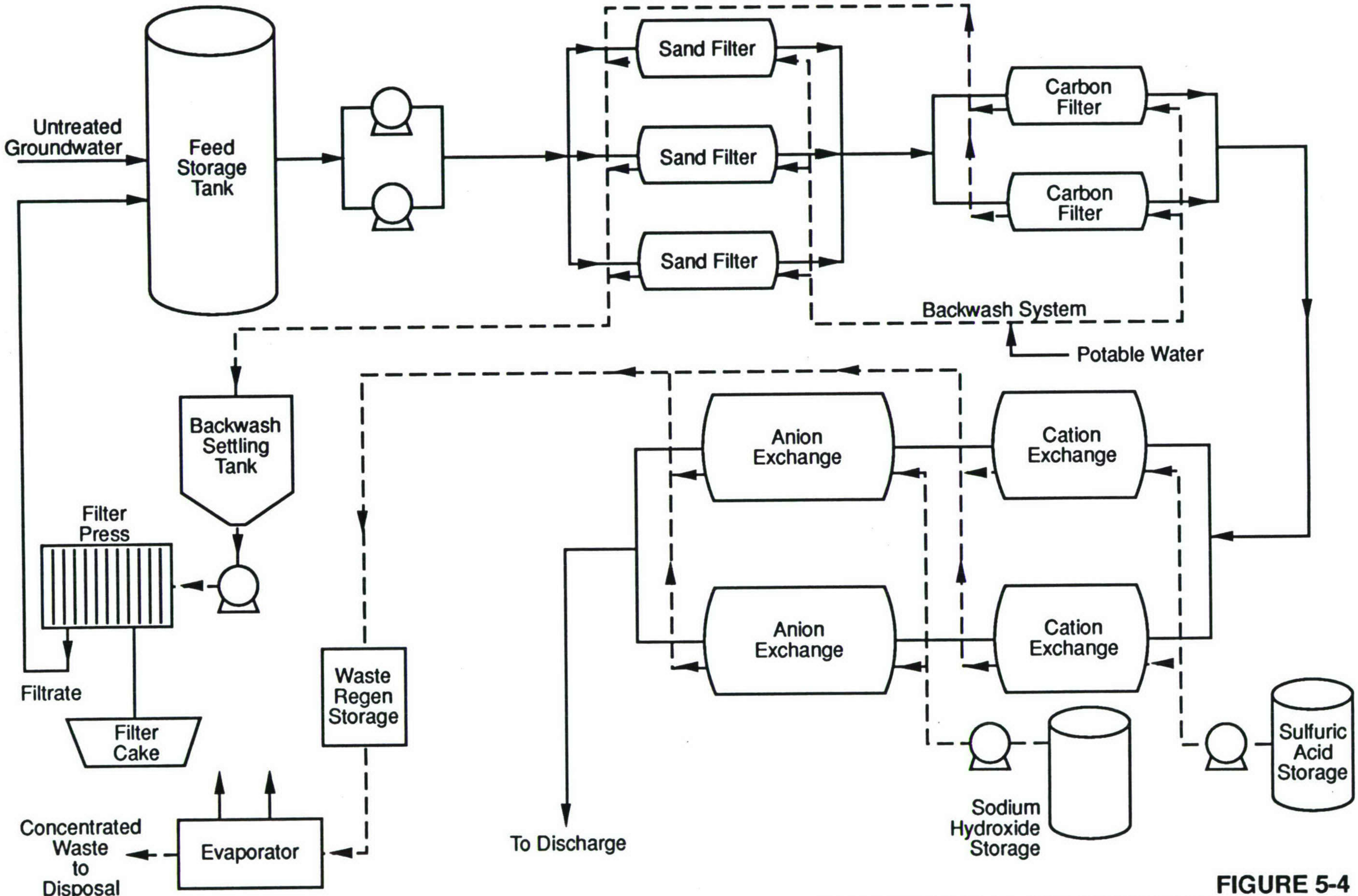

FIGURE 5-4
ALTERNATIVE SHL-5: PROCESS FLOW DIAGRAM
SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

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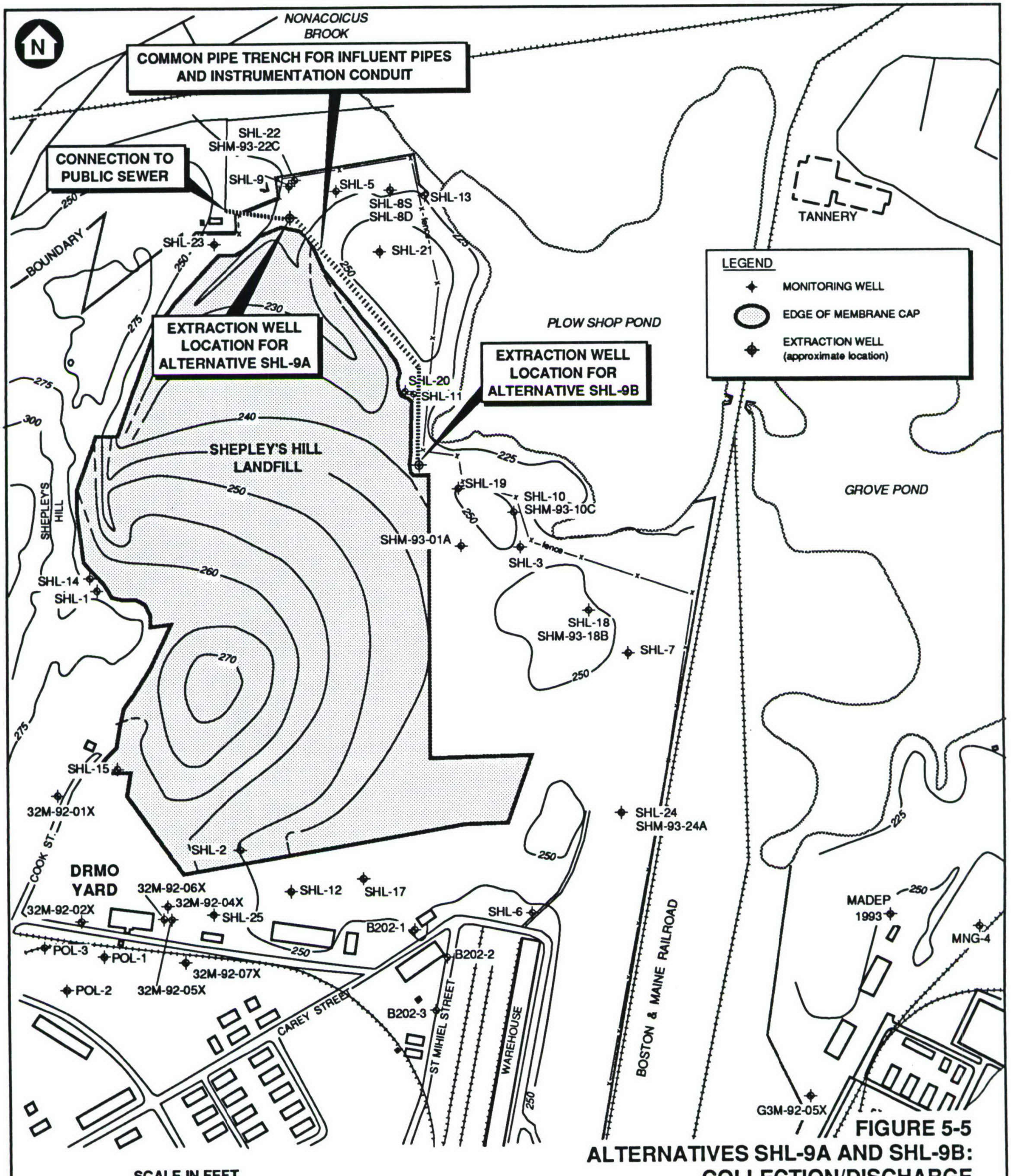

FIGURE 5-5
ALTERNATIVES SHL-9A AND SHL-9B: COLLECTION/DISCHARGE
SHEPLEY'S HILL LANDFILL OPERABLE UNIT FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ABB Environmental Services, Inc.

TABLE 5-1
ALTERNATIVE EVALUATION CRITERIA

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

THRESHOLD CRITERIA (must be met by each alternative)

- OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT - Assesses how well an alternative, as a whole, achieves and maintains protection of human health and the environment.
- COMPLIANCE WITH ARARS - Assesses how the alternative complies with location-, chemical-, and action-specific ARARs, and whether a waiver is required or justified.

PRIMARY CRITERIA (basis of alternative evaluation)

- LONG-TERM EFFECTIVENESS AND PERMANENCE - Evaluates the effectiveness of the alternative in protecting human health and the environment after response objectives have been met. Includes consideration of the magnitude of residual risks and the adequacy and reliability of controls.
- REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT - Evaluates the effectiveness of treatment processes used to reduce toxicity, mobility, and volume of hazardous substances. This criterion considers the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.
- SHORT-TERM EFFECTIVENESS - Examines the effectiveness of the alternative in protecting human health and the environment during the construction and implementation of a remedy until response objectives have been met. Considers the protection of the community, workers, and the environment during implementation of remedial actions.
- IMPLEMENTABILITY - Assesses the technical and administrative feasibility of an alternative and availability of required goods and services. Technical feasibility considers the ability to construct and operate a technology and its reliability, the ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of a remedy. Administrative feasibility considers the ability to obtain approvals from other parties or agencies and extent of required coordination with other parties or agencies.
- COST - Evaluates the capital and operation and maintenance cost of each alternative.

BALANCING CRITERIA

- STATE ACCEPTANCE - This criterion considers the state's preferences among or concerns about alternatives.
- COMMUNITY ACCEPTANCE - This criterion considers the communities preferences among or concerns about alternatives.

TABLE 5-2
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-1: NO ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Floodplains	Floodplain Management Executive Order No. 11988, [40 CFR Part 6, App. A]	Applicable	Requires federal agencies to evaluate the potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain.	No activities will occur to trigger this requirement.
	Wetlands	Protection of Wetlands Executive Order No. 11990	Applicable	Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetland areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values.	No activities will occur to trigger this requirement.

(continued)

TABLE 5-2
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-1: NO ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Surface Waters Endangered Species	Fish and Wildlife Coordination Act [16 USC 661 et seq.; 40 CFR Part 302]	Applicable	Actions which affect species/habitat require consultation with DOI, FWS, NMFS, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. The effects of water-related projects on fish and wildlife resources must be considered. Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources. Consultation with the responsible agency is also strongly recommended for on-site actions. Under 40 CFR Part 300.38, these requirements apply to all response activities under the NCP.	No activities will occur to trigger this requirement.
	Endangered Species	Endangered Species Act [16 USC 1531 et seq.; 50 CFR Part 402]	Applicable	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	No activities will occur to trigger this requirement.

(continued)

Table 5-2
Synopsis of Federal and State ARARs for Alternative SHL-1: No Action

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
State Regulatory Authority	Floodplains Wetlands	Massachusetts Wetland Protection Act and Regulations [MGL c. 131 s. 40; 310 CMR 10.00]	Applicable	Wetlands and land subject to flooding are protected under this Act and these regulations. Activities that will remove, dredge, fill, or alter protected areas (defined as areas within the 100-year floodplain) are subject to regulation and must file a Notice of Intent (NOI) with the municipal conservation commission and obtain a Final Order of Conditions before proceeding with the activity. A Determination of Applicability or NOI must be filed for activities such as excavation within a 100 foot buffer zone. The regulations specifically prohibit loss of over 5,000 square feet of bordering vegetated wetland. Loss may be permitted with replication of any lost area within two growing seasons.	No activities will occur to trigger this requirement.
	Endangered Species	Massachusetts Endangered Species Act and implementing regulations [MGL c. 131A, s. 1 et seq.; 321 CMR 8.00]	Applicable	Actions must be conducted in a manner which minimizes the impact to Massachusetts listed endangered species and species listed by the Massachusetts Natural Heritage Program.	No activities will occur to trigger this requirement.

TABLE 5-2
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-1: NO ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Area of Critical Environmental Concern	Areas of Critical Environmental Concern (ACEC) [301 CMR 12.00]	Relevant and Appropriate	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical inter-relationships among a number-of-components. An eligible area must contain features from four or more of the following groups: (1) fishery habitats; (2) coastal feature; (3) estuarine wetland; (4) inland wetland; (5) inland surface water; (6) water supply area (i.e., aquifer recharge area); (7) natural hazard area (i.e., floodplain); (8) agricultural area; (9) historical/archeological resources; (10) habitat resource (i.e., for endangered wildlife; or (11) special use areas.	No activities will occur to trigger this requirement.

(continued)

TABLE 5-2
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-1: NO ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Groundwater	SDWA, National Primary Drinking Water Standards, MCLs [40 CFR Parts 141.11 - 141.16 and 141.50-191.51]	Relevant and Appropriate	The NPDWR establishes MCLs and non-zero MCLGs for several common organic and inorganic contaminants. These MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques.	No monitoring activities will occur to evaluate compliance with these requirements.
State Regulatory Authority	Surface water	Massachusetts Surface Water Quality Standards [314 CMR 4.00]	Applicable	Massachusetts Surface Water Quality Standards designate the most sensitive uses for which surface waters of the Commonwealth are to be enhanced, maintained and protected and designate minimum water quality criteria for sustaining the designated uses. Surface waters at Fort Devens are classified as Class B. Surface waters assigned to this class are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.	No monitoring activities will occur to evaluate compliance with these requirements.

(continued)

TABLE 5-2
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-1: NO ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Groundwater	Massachusetts Groundwater Quality Standards [314 CMR 6.00]	Applicable	Massachusetts Groundwater Quality Standards designate and assign uses for which groundwaters of the Commonwealth shall be maintained and protected and set forth water quality criteria necessary to maintain the designated uses. Groundwater at Fort Devens is classified as Class I. Groundwaters assigned to this class are fresh groundwaters designated as a source of potable water supply.	No monitoring activities will occur to evaluate compliance with these requirements.
	Groundwater	Massachusetts Drinking Water Standards and Guidelines [310 CMR 22.00]	Relevant and Appropriate	The Massachusetts Drinking Water Standards and Guidelines list Massachusetts Maximum Contaminant Levels (MMCLs) which apply to water delivered to any user of a public water supply system as defined in 310 CMR 22.00. Private residential wells are not subject to the requirements of 310 CMR 22.00; however, the standards are often used to evaluate private residential contamination especially in CERCLA activities.	No monitoring activities will occur to evaluate compliance with these requirements.
	Air	Massachusetts Ambient Air Quality Standards [310 CMR 6.00]	Relevant and Appropriate	Regulations specify primary and secondary ambient air quality standards to protect public health and welfare for certain pollutants	No monitoring activities will occur to evaluate compliance with these requirements.

(continued)

TABLE 5-2
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-1: NO ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Air	Massachusetts Air Pollution Control Regulations [310 CMR 7.00]	Relevant and Appropriate	Regulations pertain to the prevention of emissions in excess of Massachusetts or national ambient air quality standards or in excess of emission limitations in those regulations.	No monitoring activities will occur to evaluate compliance with these requirements.

(continued)

TABLE 5-2
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-1: NO ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Solid waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle D, 40 CFR 258]	Relevant and Appropriate	RCRA Subtitle D regulates the generation, transport, storage, treatment, and disposal of solid wastes. Regulations at 40 CFR 258 govern preparedness and prevention, closure, and post-closure at municipal solid waste landfills.	Performance of existing cap will not be evaluated to determine compliance with the substantive requirements of federal solid waste regulations.
	Hazardous waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle C, 40 CFR 260,264]	Relevant and Appropriate	RCRA Subtitle C regulates the generation, transport, storage, treatment, and disposal of hazardous wastes. Regulations at 40 CFR 264 govern preparedness and prevention, closure, and post-closure at landfills.	Performance of existing cap will not be evaluated to determine compliance with the substantive requirements of federal hazardous waste regulations.
State Regulatory Authority	Solid waste landfill construction, operation, closure, and post-closure.	Massachusetts Solid Waste Management Regulations [310 CMR 19.100]	Applicable	These regulations outline the requirements for construction, operation, closure, and post-closure at solid waste management facilities in the Commonwealth of Massachusetts.	Performance of the existing cap will not be evaluated to determine compliance with the substantive requirements of these regulations. Post-closure monitoring requirements will not be met.
	Hazardous waste landfill construction, operation, closure, and post-closure	Massachusetts Hazardous Waste Regulations [310 CMR 30.00]	Relevant and Appropriate	Regulates handling, storage, treatment, disposal, and record keeping at hazardous waste facilities.	Performance of the existing cap will not be evaluated to determine compliance with the substantive requirements of Massachusetts hazardous waste regulations.

Notes:

DOI =
FWS =
NMFS =

TABLE 5-3
PROPOSED LONG-TERM GROUNDWATER MONITORING PROGRAM

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

MONITORING WELL LOCATIONS	MONITORING PARAMETERS
SHL-3	Volatile Organic Compounds
SHL-4	USEPA Method 624 plus acetone, 2-butanone, 2-methyl pentanone, and xylenes
SHL-5	
SHL-9	Inorganics
SHL-10	Arsenic
SHL-11	Barium
SHL-19	
SHL-20	Cadmium
SHL-22	Chromium
	Cyanide
SHM-93-10C	Iron
SHM-93-22C	Lead
3 Newly Installed Wells	Manganese
	Mercury
	Selenium
	Silver
	Copper
	Zinc
	General Parameters
	pH (measured in field)
	Temperature (measured in field)
	Specific Conductance (measured in field)
	Dissolved Oxygen (measured in field)
	Oxidation-reduction potential (measured in field)
	Total Dissolved Solids

continued

TABLE 5-3
PROPOSED LONG-TERM GROUNDWATER MONITORING PROGRAM

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

MONITORING WELL LOCATIONS	MONITORING PARAMETERS
	Total Suspended Solids
	Chloride
	Hardness
	Nitrite-Nitrate as N
	Sulfate
	Alkalinity
	Biochemical Oxygen Demand
	Chemical Oxygen Demand
	Total Organic Carbon

Note:

Groundwater elevations will be measured as part of the groundwater sampling program.

Table 5-4
Synopsis of Federal and State ARARs for Alternative SHL-2: Limited Action

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal Regulatory Authority	Floodplains	Floodplain Management Executive Order No. 11988, [40 CFR Part 6, App. A]	Applicable	Requires federal agencies to evaluate the potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain.	To the extent that any activity associated with this alternative takes place in the floodplain, the activity will be altered to comply with the law.
	Wetlands	Protection of Wetlands Executive Order No. 11990	Applicable	Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetland areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values.	To the extent that any activity associated with this alternative takes place in wetlands, the activity will be altered to comply with the law.

(continued)

TABLE 5-4
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Surface Waters Endangered Species	Fish and Wildlife Coordination Act [16 USC 661 et seq.; 40 CFR Part 302]	Applicable	Actions which affect species/habitat require consultation with DOI, FWS, NMFS, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. The effects of water-related projects on fish and wildlife resources must be considered. Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources. Consultation with the responsible agency is also strongly recommended for on-site actions. Under 40 CFR Part 300.38, these requirements apply to all response activities under the NCP.	No off-site remedial actions performed for this alternative. On-site actions would be minimal and would include agency consultation prior to implementation.
	Endangered Species	Endangered Species Act [16 USC 1531 et seq.; 50 CFR Part 402]	Applicable	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	To minimize impact, landfill cover maintenance would be performed after nesting areas of the Grasshopper Sparrow have been identified.

(continued)

TABLE 5-4
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
State Regulatory Authority	Floodplains Wetlands	Massachusetts Wetland Protection Act and Regulations [MGL c. 131 s. 40; 310 CMR 10.00]	Applicable	Wetlands and land subject to flooding are protected under this Act and these regulations. Activities that will remove, dredge, fill, or alter protected areas (defined as areas within the 100-year floodplain) are subject to regulation and must file a Notice of Intent (NOI) with the municipal conservation commission and obtain a Final Order of Conditions before proceeding with the activity. A Determination of Applicability or NOI must be filed for activities such as excavation within a 100 foot buffer zone. The regulations specifically prohibit loss of over 5,000 square feet of bordering vegetated wetland. Loss may be permitted with replication of any lost area within two growing seasons.	If remedial activities alter more than 5,000 square feet of protected area, the affected area will be restored within two growing seasons.
	Endangered Species	Massachusetts Endangered Species Act and implementing regulations [MGL c. 131A, s. 1 et seq.; 321 CMR 8.00]	Applicable	Actions must be conducted in a manner which minimizes the impact to Massachusetts listed endangered species and species listed by the Massachusetts Natural Heritage Program.	To minimize impacts, landfill cover maintenance would be performed after nesting areas of the Grasshopper Sparrow have been identified.

TABLE 5-4
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Area of Critical Environmental Concern	Areas of Critical Environmental Concern (ACEC) [301 CMR 12.00]	Relevant and Appropriate	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical inter-relationships among a number-of-components. An eligible area must contain features from four or more of the following groups: (1) fishery habitats; (2) coastal feature; (3) estuarine wetland; (4) inland wetland; (5) inland surface water; (6) water supply area (i.e., aquifer recharge area); (7) natural hazard area (i.e., floodplain); (8) agricultural area; (9) historical/archeological resources; (10) habitat resource (i.e., for endangered wildlife; or (11) special use areas.	Activities must be controlled to minimize impacts to nesting areas of the Grasshopper Sparrow.

(continued)

TABLE 5-4
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Groundwater	SDWA, National Primary Drinking Water Standards, MCLs [40 CFR Parts 141.11 - 141.16 and 141.50-191.51]	Relevant and Appropriate	The NPDWR establishes MCLs and non-zero MCLGs for several common organic and inorganic contaminants. These MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.
State Regulatory Authority	Surface water	Massachusetts Surface Water Quality Standards [314 CMR 4.00]	Applicable	Massachusetts Surface Water Quality Standards designate the most sensitive uses for which surface waters of the Commonwealth are to be enhanced, maintained and protected and designate minimum water quality criteria for sustaining the designated uses. Surface waters at Fort Devens are classified as Class B. Surface waters assigned to this class are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.	Discharges associated with remedial actions will be controlled/monitored to ensure that surface waters meet standards.

(continued)

TABLE 5-4
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Groundwater	Massachusetts Groundwater Quality Standards [314 CMR 6.00]	Applicable	Massachusetts Groundwater Quality Standards designate and assign uses for which groundwaters of the Commonwealth shall be maintained and protected and set forth water quality criteria necessary to maintain the designated uses. Groundwater at Fort Devens is classified as Class I. Groundwaters assigned to this class are fresh groundwaters designated as a source of potable water supply.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.
	Groundwater	Massachusetts Drinking Water Standards and Guidelines [310 CMR 22.00]	Relevant and Appropriate	The Massachusetts Drinking Water Standards and Guidelines list Massachusetts Maximum Contaminant Levels (MMCLs) which apply to water delivered to any user of a public water supply system as defined in 310 CMR 22.00. Private residential wells are not subject to the requirements of 310 CMR 22.00; however, the standards are often used to evaluate private residential contamination especially in CERCLA activities.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.

(continued)

TABLE 5-4
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Air	Massachusetts Ambient Air Quality Standards [310 CMR 6.00]	Relevant and Appropriate	Regulations specify primary and secondary ambient air quality standards to protect public health and welfare for certain pollutants	Ambient Air Quality Standards will be used to evaluate the performance of this alternative. If standards are exceeded, the interim remedy will be re-evaluated.
	Air	Massachusetts Air Pollution Control Regulations [310 CMR 7.00]	Relevant and Appropriate	Regulations pertain to the prevention of emissions in excess of Massachusetts or national ambient air quality standards or in excess of emission limitations in those regulations.	Ambient Air Quality Standards will be used to evaluate the performance of the cap. If standards are exceeded, the interim remedy will be re-evaluated.

(continued)

TABLE 5-4
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Solid waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle D, 40 CFR 258]	Relevant and Appropriate	RCRA Subtitle D regulates the generation, transport, storage, treatment, and disposal of solid wastes. Regulations at 40 CFR 258 govern preparedness and prevention, closure, and post-closure at municipal solid waste landfills.	Performance of this alternative as an interim remedy will be evaluated to determine compliance with the substantive requirements of federal solid waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.
	Hazardous waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle C, 40 CFR 260,264]	Relevant and Appropriate	RCRA Subtitle C regulates the generation, transport, storage, treatment, and disposal of hazardous wastes. Regulations at 40 CFR 264 govern preparedness and prevention, closure, and post-closure at landfills.	Performance of this alternative as an interim remedy will be evaluated to determine compliance with the substantive requirements of federal hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.
State Regulatory Authority	Solid waste landfill construction, operation, closure, and post-closure.	Massachusetts Solid Waste Management Regulations [310 CMR 19.100]	Applicable	These regulations outline the requirements for construction, operation, closure, and post-closure at solid waste management facilities in the Commonwealth of Massachusetts.	This alternative includes components to meet post-closure requirements at Shepley's Hill Landfill.

(continued)

TABLE 5-4
SYNOPSIS OF FEDERAL AND STATE ARARs FOR ALTERNATIVE SHL-2: LIMITED ACTION

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Hazardous waste landfill construction, operation, closure, and post-closure	Massachusetts Hazardous Waste Regulations [310 CMR 30.00]	Relevant and Appropriate	Regulates handling, storage, treatment, disposal, and record keeping at hazardous waste facilities.	Performance of this alternative as an interim remedy will be evaluated to determine compliance with the substantive requirements of Massachusetts hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.

Notes:

DOI =
FWS =
NMFS =

TABLE 5-5
SUMMARY OF COVER SYSTEM PERFORMANCE STANDARDS

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

REGULATION AND PERFORMANCE STANDARD				
MASSACHUSETTS SOLID WASTE REGULATIONS 310 CMR 19.000	**RCRA SUBTITLE C 40 CFR 264**	**RCRA SUBTITLE D 40 CFR 258**	**MASSACHUSETTS HAZARDOUS WASTE REGULATIONS 310 CMR 30.000**	**HOW COMPLIANCE IS ACHIEVED BY EXISTING COVER**
Minimize percolation of water into landfill.	Minimize migration of liquids through landfill.	Minimize infiltration through landfill.	Minimize migration of liquids through landfill.	Geomembrane installations such as the existing one at Shepley's Hill Landfill have a permeability of $1x10^{-7}$ cm/sec or less that minimizes infiltration and migration of liquid into landfilled waste. Sloped surface promotes runoff and minimizes infiltration. Vegetation promotes evapotranspiration.
	Have a permeability less than or equal to bottom liner or subsoils.	Have a permeability less than or equal to bottom liner or subsoils or less than $1x10^{-5}$ cm/sec, whichever is less.	Have a permeability less than or equal to bottom liner.	Existing geomembrane permeability is less than that of sands underlying landfill. There is no bottom liner.
Promote drainage of precipitation.	Promote drainage and minimize erosion.		Promote drainage and minimize erosion of cover.	The existing cover is sloped to promote drainage and vegetated to prevent erosion.

(continued)

TABLE 5-5
SUMMARY OF COVER SYSTEM PERFORMANCE STANDARDS

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

REGULATION AND PERFORMANCE STANDARD				
MASSACHUSETTS SOLID WASTE REGULATIONS 310 CMR 19.000	**RCRA SUBTITLE C 40 CFR 264**	**RCRA SUBTITLE D 40 CFR 258**	**MASSACHUSETTS HAZARDOUS WASTE REGULATIONS 310 CMR 30.000**	**HOW COMPLIANCE IS ACHIEVED BY EXISTING COVER**
Minimize erosion of final cover.		Minimize erosion of final cover.		The existing cover is sloped and vegetated to minimize erosion.
	Function with minimum maintenance.		Function with minimum maintenance.	The existing cover was constructed in a manner to minimize maintenance. Monitoring and maintenance of cover systems to maintain integrity is normal practice.
Facilitate gas venting.				The existing collection piping and riser system facilitate gas venting. Analysis of gas samples from vents confirms that they function.
Accommodate settling and subsidence to continue to meet performance standards.	Accommodate settling and subsidence to maintain cover integrity.		Accommodate settling and subsidence to maintain cover integrity.	Landfill materials were compacted and graded during construction of the existing cap to accommodate settling. Maintenance actions are possible to maintain cover integrity if or when settling occurs.
Ensure isolate of wastes from environment.				The existing cover isolates wastes from potential terrestrial receptors by covering them with soil and lowers groundwater to elevations interpreted to be below waste.

TABLE 5–6
COST SUMMARY TABLE
ALTERNATIVE SHL–2: LIMITED ACTION

FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ITEM	COST
DIRECT COSTS	
Mobilization	$90,000
Landfill cover repairs	$611,000
Institutional controls and educational programs	$13,000
TOTAL DIRECT COST	$714,000
INDIRECT COSTS	
Health and Safety @ 5% of total direct cost	$36,000
Legal, Administrative, Permitting @ 5% of total direct cost	$36,000
Engineering @ 10% of total direct cost	$71,000
Services during construction @ 10% of total direct cost	$71,000
TOTAL INDIRECT COST	$214,000
TOTAL CAPITAL (DIRECT AND INDIRECT) COST	$928,000
OPERATION AND MAINTENANCE COSTS	
Total annual operating and maintenance costs	$84,000
TOTAL PRESENT WORTH OF O&M COSTS (5% FOR 30 YEARS)	$1,219,000
TOTAL PRESENT WORTH OF ALTERNATIVE	$2,219,000

TABLE 5-7
GROUNDWATER INFLUENT AND DISCHARGE LIMITATIONS

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

PARAMETER	AWQC AQUATIC LIFE ($\mu g/L$)	BACKGROUND CONCENTRATION ($\mu g/L$)[1]	ESTIMATED GROUNDWATER INFLUENT CONCENTRATION ($\mu g/L$)[2]	ALLOWABLE EFFLUENT CONCENTRATION IN 30 GPM DISCHARGE TO MEET AWQC ($\mu g/L$)[3]	ASSUMED DISCHARGE LIMITATION IN 30 GPM DISCHARGE TO NONACOICUS BROOK ($\mu g/L$)
INORGANICS					
Aluminum	87	<81.5	1,870	1,876[C]	1,876
Arsenic	190	<7.0	150	7,445[C]	7,445
Chromium	88[A]	<4.5	NE	3,442[C]	3,442
Copper	4.8[A]	<4.6	7.3	102[C]	102
Iron	1,000	377[B]	15,300	25,235	25,235
Lead	0.85[A]	<4.74	3.8	D	4.7
Manganese	NE	490	2,635	20,839[E]	20,839
Nickel	65[A]	8.8	NE	2,251	2,251

Notes:

1 = Background concentration based on sample SW-SHL-15 from Nonacoicus Brook unless noted (E&E, 1993).
2 = Based on the time-weighted average using CORA model. See Appendix C.
3 = Calculated to meet AWQC in Nonacoicus Brook at 7Q10. See Appendix D.
A = AWQC based on hardness of 35 mg $CaCO_3$/L.
B = Iron in sample SW-SHL-15 was reported at 1,100 $\mu g/L$; however in 13 samples from Plow Shop Pond iron ranged between 214-500 $\mu g/L$ with an average of 377 $\mu g/L$. The average was considered a better representation and was used for calculation purposes.
C = Background concentrations used were one-half of sample quantitation limit (SQL).
D = Calculated concentration is less than background concentration.
E = Calculated concentration based on 1,000 $\mu g/L$ from McKee and Wolf, 1963/USEPA, 1976.
NE = Not Established.

Table 5-8
Synopsis of Federal and State ARARs for Alternative SHL-5:
Collection/Ion Exchange Treatment/Surface Water Discharge

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal Regulatory Authority	Floodplains	Floodplain Management Executive Order No. 11988	Applicable	Requires federal agencies to evaluate the potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain.	Any construction activities within a floodplain or wetland, including construction of a discharge pipeline to Nonacoicus Brook, will be done in a manner to minimize impacts. Altered areas will be repaired or restored.
	Wetlands	Protection of Wetlands Executive Order No. 11990 [40 CFR Part 6 App. A]	Applicable	Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetland areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values.	Any construction activities within a floodplain or wetland, including construction of a discharge pipeline to Nonacoicus Brook, will be done in a manner to minimize impacts. Altered areas will be repaired or restored.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5:
COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Surface Waters Endangered Species	Fish and Wildlife Coordination Act [16 USC 661 et seq.; 40 CFR Part 302]	Applicable	Actions which affect species/habitat require consultation with DOI, FWS, NMFS, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. The effects of water-related projects on fish and wildlife resources must be considered. Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources. Consultation with the responsible agency is also strongly recommended for on-site actions. Under 40 CFR Part 300.38, these requirements apply to all response activities under the NCP.	No off-site remedial actions performed for this alternative. On-site actions would include agency consultation prior to and during implementation.
	Endangered Species	Endangered Species Act [16 USC 1531 et seq.; 50 CFR Part 402]	Applicable	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	To minimize impacts, remedial actions would be performed after nesting areas of the Grasshopper Sparrow have been identified.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5:
COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
State Regulatory Authority	Floodplains Wetlands	Massachusetts Wetland Protection Act and regulations [MGL c. 131 s. 40; 310 CMR 10.00]	Applicable	Wetlands and land subject to flooding are protected under this Act and these regulations. Activities that will remove, dredge, fill, or alter protected areas (defined as areas within the 100-year floodplain) are subject to regulation and must file a Notice of Intent (NOI) with the municipal conservation commission and obtain a Final Order of Conditions before proceeding with the activity. A Determination of Applicability or NOI must be filed for activities such as excavation within a 100 foot buffer zone. The regulations specifically prohibit loss of over 5,000 square feet of bordering vegetated wetland. Loss may be permitted with replication of any lost area within two growing seasons.	If remedial activities alter more than 5,000 square feet of protected area, the affected area will be restored within two growing seasons.
	Endangered Species	Massachusetts Endangered Species Act and implementing regulations [MGL c. 131A, s. 1 et seq.; 321 CMR 8.00]	Applicable	Actions must be conducted in a manner which minimizes the impact to Massachusetts-listed endangered species and species listed by the Massachusetts Natural Heritage Program.	To minimize impacts, remedial actions would be performed after nesting areas of the Grasshopper Sparrow have been identified.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5:
COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Area of Critical Environmental Concern	Areas of Critical Environmental Concern (ACEC) [301 CMR 12.00]	Relevant and Appropriate	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical inter-relationships among a number-of-components. An eligible area must contain features from four or more of the following groups: (1) fishery habitats; (2) coastal feature; (3) estuarine wetland; (4) inland wetland; (5) inland surface water; (6) water supply area (i.e., aquifer recharge area); (7) natural hazard area (i.e., floodplain); (8) agricultural area; (9) historical/archeological resources; (10) habitat resource (i.e., for endangered wildlife; or (11) special use areas.	Activities must be controlled to minimize impacts to nesting areas of the Grasshopper Sparrow.

(continued)

Table 5-8
Synopsis of Federal and State ARARs for Alternative SHL-5: Collection/Ion Exchange Treatment/Surface Water Discharge

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Authority	Chemical Medium	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal Regulatory Authority	Surface water	CWA, Ambient Water Quality Criteria [40 CFR 131; Quality Criteria for Water 1986]	Relevant and Appropriate	Federal AWQC include (1) human health based criteria developed for 95 carcinogenic and noncarcinogenic compounds and (2) acute and chronic toxicity values for the protection of aquatic life. AWQC for the protection of human health provide protective concentrations for exposure from ingesting contaminated water and contaminated aquatic organisms, and from ingesting contaminated aquatic organisms alone. Remedial actions involving contaminated surface water or discharge of contaminants to surface water must consider the uses of the water and the circumstances of the release or threatened release; this determines whether AWQC are relevant and appropriate.	The discharge to Nonacoicus Brook will be monitored to ensure that AWQC are not exceeded in the brook.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Groundwater	SDWA, National Primary Drinking Water Standards, MCLs [40 CFR Parts 141.11 - 141.16 and 141.50-141.51]	Relevant and Appropriate	The NPDWR establishes MCLs and non-zero MCLGs for several common organic and inorganic contaminants. These MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.
State Regulatory Authority	Surface water	Massachusetts Surface Water Quality Standards [314 CMR 4.00]	Applicable	Massachusetts Surface Water Quality Standards designate the most sensitive uses for which surface waters of the Commonwealth are to be enhanced, maintained and protected and designate minimum water quality criteria for sustaining the designated uses. Surface waters at Fort Devens are classified as Class B. Surface waters assigned to this class are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.	Discharges associated with remedial actions will be monitored/controlled to ensure that surface waters meet standards.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5:
COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Groundwater	Massachusetts Groundwater Quality Standards [314 CMR 6.00]	Applicable	Massachusetts Groundwater Quality Standards designate and assign uses for which groundwaters of the Commonwealth shall be maintained and protected and set forth water quality criteria necessary to maintain the designated uses. Groundwater at Fort Devens is classified as Class I. Groundwaters assigned to this class are fresh groundwaters designated as a source of potable water supply.	Massachusetts Groundwater Quality Standards will be used to evaluate the performance of this alternative. If standards are exceeded, the interim remedy will be re-evaluated.
	Groundwater	Massachusetts Drinking Water Standards and Guidelines [310 CMR 22.00]	Relevant and Appropriate	The Massachusetts Drinking Water Standards and Guidelines list Massachusetts Maximum Contaminant Levels (MMCLs) which apply to water delivered to any user of a public water supply system as defined in 310 CMR 22.00. Private residential wells are not subject to the requirements of 310 CMR 22.00; however, the standards are often used to evaluate private residential contamination especially in CERCLA activities.	MMCLs will be used to evaluate the performance of this alternative. If MMCLs are exceeded, the interim remedy will be re-evaluated.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5:
COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Air	Massachusetts Ambient Air Quality Standards [310 CMR 6.00]	Relevant and Appropriate	Regulations specify primary and secondary ambient air quality standards to protect public health and welfare for certain pollutants	Ambient Air Quality Standards will be used to evaluate the performance of this alternative. If standards are exceeded, the interim remedy will be re-evaluated.
	Air	Massachusetts Air Pollution Control Regulations [310 CMR 7.00]	Relevant and Appropriate	Regulations pertain to the prevention of emissions in excess of Massachusetts or national ambient air quality standards or in excess of emission limitations in those regulations.	Ambient Air Quality Standards will be used to evaluate the performance of this alternative. If standards are exceeded, the interim remedy will be re-evaluated.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5:
COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Construction over/in navigable waters	Rivers and Harbors Act of 1899 [33 USC 401 et seq.]	Applicable	Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the Secretary of the Army, acting through the U.S. Army Corps of Engineers (USACE), for the construction of any structure in or over any "navigable water of the U.S.," the excavation from or deposition of material in such waters, or any obstruction or alteration in such waters.	Permits not required for CERCLA on-site actions, substantive requirements would be met.
	Control of surface water runoff. Direct discharge to surface water	CWA, NPDES Permit Program [40 CFR 122, 125]	Applicable	The NPDES permit program specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. Both on-site and off-site discharges to surface waters are required to meet the requirements of the issued NPDES permit, including discharge limitations, monitoring requirements, and best management practices.	Permits not required for CERCLA on-site actions, substantive requirements would be met.
	Solid waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle D, 40 CFR 258]	Relevant and Appropriate	RCRA Subtitle D regulates the generation, transport, storage, treatment, and disposal of solid wastes. Regulations at 40 CFR 258 govern preparedness and prevention, closure, and post-closure at municipal solid waste landfills.	Performance of this alternative as an interim remedy will be evaluated to determine compliance with the substantive requirements of federal solid waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Hazardous waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle C, 40 CFR 260,264]	Relevant and Appropriate	RCRA Subtitle C regulates the generation, transport, storage, treatment, and disposal of hazardous wastes. Regulations at 40 CFR 264 govern preparedness and prevention, closure, and post-closure at landfills.	Performance of this alternative as in interim remedy will be evaluated to determine compliance with the substantive requirements of federal hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.
	Placement of excavated soil/ sediment. Disposal of treatment residues	RCRA, Land Disposal Restrictions [40 CFR 268]	Applicable	Land disposal of RCRA hazardous wastes without specified treatment is restricted. Remedial actions must be evaluated to determine if they constitute "placement" and if LDRs are applicable. The LDRs require that wastes must be treated either by a treatment technology or to a specific concentration prior to disposal in a RCRA Subtitle C permitted facility.	Filter cake and concentrate from ion exchange regeneration would be tested to evaluate if they are classified as a characteristic hazardous waste for proper disposal.
State Regulatory Authority	Excavation/ construction	Massachusetts Air Pollution Control Regulations [310 CMR 6.00 - 7.00]	Applicable	Particulate emissions from remedial activities must not exceed an annual geometric mean of 50 g/m^3 and a maximum 24-hour concentration of 150 mg/m^3 (primary standard). Carbon monoxide, nitrogen dioxide, and lead are also regulated. A permit and BACT approval are required prior to operation. Visible emissions are limited.	Emissions will be managed through engineering controls.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5:
COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Solid waste landfill construction, operation, closure, and post-closure.	Massachusetts Solid Waste Management Regulations [310 CMR 19.100]	Applicable	These regulations outline the requirements for construction, operation, closure, and post-closure at solid waste management facilities in the Commonwealth of Massachusetts.	This alternative includes components to meet post-closure requirements at Shepley's Hill Landfill.
	Hazardous waste landfill construction, operation, closure, and post-closure	Massachusetts Hazardous Waste Regulations [310 CMR 30.00]	Relevant and Appropriate	Regulates handling, storage, treatment, disposal, and record keeping at hazardous waste facilities.	Performance of this alternative as in interim remedy will be evaluated to determine compliance with the substantive requirements of Massachusetts hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.
	Construction over/in a waterway	Massachusetts Waterways Act [MGL c. 91; 310 CMR 9.00]	Applicable	The Massachusetts Waterways Act and regulations require that a license from MADEP be obtained for any work in or over any tidelands, river or stream (with respect to which public funds have been expended), or great pond, or outlet thereof.	Permits not required for CERCLA on-site actions, substantive requirements would be met.

(continued)

TABLE 5-8
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Activities that potentially affect surface water quality	Massachusetts Water Quality Certification and Certification for Dredging [314 CMR 9.00]	Applicable	For activities that require a MADEP Wetlands Order of Conditions to dredge or fill navigable waters or wetlands, a Chapter 91 Waterways License, a USACE permit or any major permit issued by USEPA (e.g., CWA NPDES permit), a Massachusetts Division of Water Pollution Control Water Quality Certification is required pursuant to 314 CMR 9.00.	A water quality certification would be acquired prior to constructing a discharge location in Nonacoicus Brook.

TABLE 5-9
COST SUMMARY TABLE
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE

FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ITEM	COST
DIRECT COSTS	
Hydrogeological study	$126,000
Treatability/Pilot Testing	$65,000
Site preparation and mobilization	$283,000
Ditch and Landfill cover repairs	$611,000
Extraction system/discharge pipe construction	$152,000
Treatment facility construction	$733,000
Institutional controls and educational programs	$13,000
TOTAL DIRECT COST	$1,983,000
INDIRECT COSTS	
Health and Safety @ 5% of total direct cost	$99,000
Legal, Administrative, Permitting @ 5% of total direct cost	$99,000
Engineering @ 10% of total direct cost	$198,000
Services during construction @ 10% of total direct cost	$198,000
TOTAL INDIRECT COST	$594,000
TOTAL CAPITAL (DIRECT AND INDIRECT) COST	$2,577,000
OPERATION AND MAINTENANCE COSTS	
Total annual operating and maintenance costs	$426,000
TOTAL PRESENT WORTH OF O&M COSTS (5% FOR 30 YEARS)	$6,549,000
TOTAL PRESENT WORTH OF ALTERNATIVE	$9,126,000

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TABLE 5-10
AYER POTW PRETREATMENT REQUIREMENTS

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FT. DEVENS, MA

PARAMETER	ESTIMATED GROUNDWATER INFLUENT CONCENTRATION (μg/L)[1]	AYER POTW LOCAL LIMIT (μg/L)
INORGANICS		
Aluminum	1,870	NE
Arsenic	150	300
Chromium	NE	2,000
Copper	7.3	1,000
Iron	15,300	NE
Lead	3.8	250
Manganese	2,635	NE
Nickel	NE	1,000

Notes:

1 = Based on time-weighted average for unfiltered samples using CORA model. See Appendix C for calculations.
NE = Not Established.

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Floodplains	Floodplain Management Executive Order No. 11988 [40 CFR Part 6, App. A]	Applicable	Requires federal agencies to evaluate the potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain.	Any construction activities within a floodplain or wetland, including construction of a force main will be done in a manner to minimize impacts. Altered areas will be repaired to restored.
	Wetlands	Protection of Wetlands Executive Order No. 11990	Applicable	Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetland areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values.	Any construction activities within a floodplain or wetland, including construction of a force main will be done in a manner to minimize impacts. Altered areas will be repaired to restored.

(continued)

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Surface Waters Endangered Species	Fish and Wildlife Coordination Act [16 USC 661 et seq.; 40 CFR Part 302]	Applicable	Actions which affect species/habitat require consultation with DOI, FWS, NMFS, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. The effects of water-related projects on fish and wildlife resources must be considered. Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources. Consultation with the responsible agency is also strongly recommended for on-site actions. Under 40 CFR Part 300.38, these requirements apply to all response activities under the NCP.	No off-site remedial actions performed for this alternative. On-site actions would include agency consultation prior to and during implementation.
	Endangered Species	Endangered Species Act [16 USC 1531 et seq.; 50 CFR Part 402]	Applicable	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	To minimize impacts, remedial actions would be performed after nesting areas of the Grasshopper Sparrow have been identified.

(continued)

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
State Regulatory Authority	Floodplains Wetlands	Massachusetts Wetland Protection Act and Regulations [MGL c. 131 s. 40; 310 CMR 10.00]	Applicable	Wetlands and land subject to flooding are protected under this Act and these regulations. Activities that will remove, dredge, fill, or alter protected areas (defined as areas within the 100-year floodplain) are subject to regulation and must file a Notice of Intent (NOI) with the municipal conservation commission and obtain a Final Order of Conditions before proceeding with the activity. A Determination of Applicability or NOI must be filed for activities such as excavation within a 100 foot buffer zone. The regulations specifically prohibit loss of over 5,000 square feet of bordering vegetated wetland. Loss may be permitted with replication of any lost area within two growing seasons.	If remedial activities alter more than 5,000 square feet of protected area, the affected area will be restored within two growing seasons.
	Endangered Species	Massachusetts Endangered Species Act and implementing regulations [MGL c. 131A, s. 1 et seq.; 321 CMR 8.00]	Applicable	Actions must be conducted in a manner which minimizes the impact to Massachusetts listed endangered species and species listed by the Massachusetts Natural Heritage Program.	To minimize impacts, remedial actions would be performed after nesting areas of the Grasshopper Sparrow have been identified.

(continued)

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Area of Critical Environmental Concern	Areas of Critical Environmental Concern (ACEC) (301 CMR 12.00)	Relevant and Appropriate	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical inter-relationships among a number-of-components. An eligible area must contain features from four or more of the following groups: (1) fishery habitats; (2) coastal feature; (3) estuarine wetland; (4) inland wetland; (5) inland surface water; (6) water supply area (i.e., aquifer recharge area); (7) natural hazard area (i.e., floodplain); (8) agricultural area; (9) historical/archeological resources; (10) habitat resource (i.e., for endangered wildlife; or (11) special use areas.	Activities must be controlled to minimize impacts to nesting areas of the Grasshopper Sparrow.

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Groundwater	SDWA, National Primary Drinking Water Standards, MCLs [40 CFR Parts 141.11 - 141.16 and 141.50-141.51]	Relevant and Appropriate	The NPDWR establishes MCLs and non-zero MCLGs for several common organic and inorganic contaminants. These MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be evaluated.
State Regulatory Authority	Surface water	Massachusetts Surface Water Quality Standards [314 CMR 4.00]	Applicable	Massachusetts Surface Water Quality Standards designate the most sensitive uses for which surface waters of the Commonwealth are to be enhanced, maintained and protected and designate minimum water quality criteria for sustaining the designated uses. Surface waters at Fort Devens are classified as Class B. Surface waters assigned to this class are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.	Discharges associated with remedial actions will be controlled/monitored to ensure that surface waters meet standards.

(continued)

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Groundwater	Massachusetts Groundwater Quality Standards [314 CMR 6.00]	Applicable	Massachusetts Groundwater Quality Standards designate and assign uses for which groundwaters of the Commonwealth shall be maintained and protected and set forth water quality criteria necessary to maintain the designated uses. Groundwater at Fort Devens is classified as Class I. Groundwaters assigned to this class are fresh groundwaters designated as a source of potable water supply.	Massachusetts Groundwater Quality Standards will be used to evaluate performance of this alternative. If standards are exceeded, the interim remedy will be re-evaluated.
	Groundwater	Massachusetts Drinking Water Standards and Guidelines [310 CMR 22.00]	Relevant and Appropriate	The Massachusetts Drinking Water Standards and Guidelines list Massachusetts Maximum Contaminant Levels (MMCLs) which apply to water delivered to any user of a public water supply system as defined in 310 CMR 22.00. Private residential wells are not subject to the requirements of 310 CMR 22.00; however, the standards are often used to evaluate private residential contamination especially in CERCLA activities.	MMCLs will be used to evaluate performance of this alternative. If MMCLs are exceeded, the interim remedy will be re-evaluated.

(continued)

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
State Regulatory Authority	Floodplains Wetlands	Massachusetts Wetland Protection Act and Regulations [MGL c. 131 s. 40; 310 CMR 10.00]	Applicable	Wetlands and land subject to flooding are protected under this Act and these regulations. Activities that will remove, dredge, fill, or alter protected areas (defined as areas within the 100-year floodplain) are subject to regulation and must file a Notice of Intent (NOI) with the municipal conservation commission and obtain a Final Order of Conditions before proceeding with the activity. A Determination of Applicability or NOI must be filed for activities such as excavation within a 100 foot buffer zone. The regulations specifically prohibit loss of over 5,000 square feet of bordering vegetated wetland. Loss may be permitted with replication of any lost area within two growing seasons.	If remedial activities alter more than 5,000 square feet of protected area, the affected area will be restored within two growing seasons.

(continued)

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Discharge to POTW.	CWA, General Pretreatment Program [40 CFR Part 403]	Applicable	Discharges of nondomestic wastewater to POTWs must comply with the general prohibitions of this regulation, as well as categorical standards, and local pretreatment standards.	Discharge to POTW would be sampled to evaluate compliance with pre-treatment standards.
	Solid waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle D, 40 CFR 258]	Relevant and Appropriate	RCRA Subtitle D regulates the generation, transport, storage, treatment, and disposal of solid wastes. Regulations at 40 CFR 258 govern preparedness and prevention, closure, and post-closure at municipal solid waste landfills.	Performance of this alternative as in interim remedy will be evaluated to determine compliance with the substantive requirements of federal hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.
	Hazardous waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle C, 40 CFR 260,264]	Relevant and Appropriate	RCRA Subtitle C regulates the generation, transport, storage, treatment, and disposal of hazardous wastes. Regulations at 40 CFR 264 govern preparedness and prevention, closure, and post-closure at landfills.	Performance of this alternative as in interim remedy will be evaluated to determine compliance with the substantive requirements of federal hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.

(continued)

TABLE 5-11
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
State Regulatory Authority	Excavation/ construction	Massachusetts Air Pollution Control Regulations [310 CMR 6.00 - 7.00]	Applicable	Particulate emissions from remedial activities must not exceed an annual geometric mean of 50 g/m^3 and a maximum 24-hour concentration of 150 mg/m^3 (primary standard). Carbon monoxide, nitrogen dioxide, and lead are also regulated. A permit and BACT approval are required prior to operation. Visible emissions are limited.	Emissions will be managed through engineering controls.
	Solid waste landfill construction, operation, closure, and post-closure	Massachusetts Solid Waste Management Regulations [314 CMR 19.100]	Applicable	These regulations outline the requirements for construction, operation, closure, and post closure at solid waste management facilities in the Commonwealth of Massachusetts.	This alternative includes components to meet post-closure requirements at Shepley's Hill Landfill.
	Hazardous waste landfill construction, operation, closure, and post-closure	Massachusetts Hazardous Waste Regulations [310 CMR 30.00]	Relevant and Appropriate	Regulates handling, storage, treatment, disposal, and record keeping at hazardous waste facilities.	Performance of this alternative as in interim remedy will be evaluated to determine compliance with the substantive requirements of Massachusetts hazardous waste regulations. If the substantive requirements are not met at the appropriate time, the interim remedy will be re-evaluated.

TABLE 5-12
COST SUMMARY TABLE
ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ITEM	COST
DIRECT COSTS	
Hydrogeological study	$126,000
Site preparation and mobilization	$134,000
Ditch and landfill cover repairs	$611,000
Extraction system/discharge pipe construction	$26,000
Institutional controls and educational programs	$13,000
TOTAL DIRECT COST	$910,000
INDIRECT COSTS	
Health and Safety @ 5% of total direct cost	$46,000
Legal, Administrative, Permitting @ 5% of total direct cost	$46,000
Engineering @ 10% of total direct cost	$91,000
Services during construction @ 10% of total direct cost	$91,000
TOTAL INDIRECT COST	$274,000
TOTAL CAPITAL (DIRECT AND INDIRECT) COST	$1,184,000
OPERATION AND MAINTENANCE COSTS	
Total annual operating and maintenance costs	$175,000
TOTAL PRESENT WORTH OF O&M COSTS (5% FOR 30 YEARS)	$2,690,000
TOTAL PRESENT WORTH OF ALTERNATIVE	$3,874,000

Table 5-13
Synopsis of Federal and State ARARs for Alternative SHL-10: Installation of RCRA Cap

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal Regulatory Authority	Floodplains	Floodplain Management Executive Order No. 11988, [40 CFR Part 6, App. A]	Applicable	Requires federal agencies to evaluate the potential adverse effects associated with direct and indirect development of a floodplain. Alternatives that involve modification/construction within a floodplain may not be selected unless a determination is made that no practicable alternative exists. If no practicable alternative exists, potential harm must be minimized and action taken to restore and preserve the natural and beneficial values of the floodplain.	To the extent that any activity associated with this alternative takes place in the floodplain, the activity will be altered to comply with the law.
	Wetlands	Protection of Wetlands Executive Order No. 11990	Applicable	Under this Order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands. If remediation is required within wetland areas, and no practical alternative exists, potential harm must be minimized and action taken to restore natural and beneficial values.	To the extent that any activity associated with this alternative takes place in wetlands, the activity will be altered to comply with the law.

(continued)

TABLE 5-13
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Surface Waters Endangered Species	Fish and Wildlife Coordination Act [16 USC 661 et seq.; 40 CFR Part 302]	Applicable	Actions which affect species/habitat require consultation with DOI, FWS, NMFS, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. The effects of water-related projects on fish and wildlife resources must be considered. Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources. Consultation with the responsible agency is also strongly recommended for on-site actions. Under 40 CFR Part 300.38, these requirements apply to all response activities under the NCP.	No off-site remedial actions performed for this alternative. On-site actions would include agency consultation prior to implementation.
	Endangered Species	Endangered Species Act [16 USC 1531 et seq.; 50 CFR Part 402]	Applicable	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Installation of a new landfill cover would destroy any existing nesting areas of the Grasshopper Sparrow.

(continued)

TABLE 5-13
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
State Regulatory Authority	Floodplains Wetlands	Massachusetts Wetland Protection Act and Regulations [MGL c. 131 s. 40; 310 CMR 10.00]	Applicable	Wetlands and land subject to flooding are protected under this Act and these regulations. Activities that will remove, dredge, fill, or alter protected areas (defined as areas within the 100-year floodplain) are subject to regulation and must file a Notice of Intent (NOI) with the municipal conservation commission and obtain a Final Order of Conditions before proceeding with the activity. A Determination of Applicability or NOI must be filed for activities such as excavation within a 100 foot buffer zone. The regulations specifically prohibit loss of over 5,000 square feet of bordering vegetated wetland. Loss may be permitted with replication of any lost area within two growing seasons.	If remedial activities alter more than 5,000 square feet of protected area, the affected area will be restored within two growing seasons.
	Endangered Species	Massachusetts Endangered Species Act and implementing regulations [MGL c. 131A, s. 1 et seq.; 321 CMR 8.00]	Applicable	Actions must be conducted in a manner which minimizes the impact to Massachusetts listed endangered species and species listed by the Massachusetts Natural Heritage Program.	Activities would be controlled and planned to minimize impacts to nesting areas of the Grasshopper Sparrow. Inspite of this, existing nesting areas would be destroyed during construction activities.

(continued)

TABLE 5-13
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	LOCATION CHARACTERISTIC	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Area of Critical Environmental Concern	Areas of Critical Environmental Concern (ACEC) [301 CMR 12.00]	Relevant and Appropriate	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical inter-relationships among a number-of-components. An eligible area must contain features from four or more of the following groups: (1) fishery habitats; (2) coastal feature; (3) estuarine wetland; (4) inland wetland; (5) inland surface water; (6) water supply area (i.e., aquifer recharge area); (7) natural hazard area (i.e., floodplain); (8) agricultural area; (9) historical/archeological resources; (10) habitat resource (i.e., for endangered wildlife; or (11) special use areas.	Activities would be controlled and planned to minimize impacts to nesting areas of the Grasshopper Sparrow. Inspite of this, existing nesting areas would be destroyed during construction activities.

(continued)

Table 5-13
Synopsis of Federal and State ARARs for Alternative SHL-10: Installation of RCRA Cap

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Authority	Chemical Medium	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal Regulatory Authority	Groundwater	SDWA, National Primary Drinking Water Standards, MCLs [40 CFR Parts 141.11 - 141.16 and 141.50-191.51]	Relevant and Appropriate	The NPDWR establishes MCLs and non-zero MCLGs for several common organic and inorganic contaminants. These MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.
State Regulatory Authority	Surface water	Massachusetts Surface Water Quality Standards [314 CMR 4.00]	Applicable	Massachusetts Surface Water Quality Standards designate the most sensitive uses for which surface waters of the Commonwealth are to be enhanced, maintained and protected and designate minimum water quality criteria for sustaining the designated uses. Surface waters at Fort Devens are classified as Class B. Surface waters assigned to this class are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.	Discharges associated with remedial actions will be controlled/monitored to ensure that surface waters meet standards.

(continued)

TABLE 5-13
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	CHEMICAL MEDIUM	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
	Groundwater	Massachusetts Groundwater Quality Standards [314 CMR 6.00]	Applicable	Massachusetts Groundwater Quality Standards designate and assign uses for which groundwaters of the Commonwealth shall be maintained and protected and set forth water quality criteria necessary to maintain the designated uses. Groundwater at Fort Devens is classified as Class I. Groundwaters assigned to this class are fresh groundwaters designated as a source of potable water supply.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.
	Groundwater	Massachusetts Drinking Water Standards and Guidelines [310 CMR 22.00]	Relevant and Appropriate	The Massachusetts Drinking Water Standards and Guidelines list Massachusetts Maximum Contaminant Levels (MMCLs) which apply to water delivered to any user of a public water supply system as defined in 310 CMR 22.00. Private residential wells are not subject to the requirements of 310 CMR 22.00; however, the standards are often used to evaluate private residential contamination especially in CERCLA activities.	MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.

(continued)

Table 5-13
Synopsis of Federal and State ARARs for Alternative SHL-10: Installation of RCRA Cap

Shepley's Hill Landfill Operable Unit
Feasibility Study for Group 1A Sites
Fort Devens, MA

Authority	Chemical Medium	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
	Air	Massachusetts Ambient Air Quality Standards [310 CMR 6.00]	Relevant and Appropriate	Regulations specify primary and secondary ambient air quality standards to protect public health and welfare for certain pollutants	Ambient Air Quality Standards will be used to evaluate the performance of this alternative. If standards are exceeded, the interim remedy will be re-evaluated.
	Air	Massachusetts Air Pollution Control Regulations [310 CMR 7.00]	Relevant and Appropriate	Regulations pertain to the prevention of emissions in excess of Massachusetts or national ambient air quality standards or in excess of emission limitations in those regulations.	Ambient Air Quality Standards will be used to evaluate the performance of the cap. If standards are exceeded, the interim remedy will be re-evaluated.

(continued)

TABLE 5-13
SYNOPSIS OF FEDERAL AND STATE ARARS FOR ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

AUTHORITY	ACTION	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN REQUIREMENT
Federal Regulatory Authority	Solid waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle D, 40 CFR 258]	Relevant and Appropriate	RCRA Subtitle D regulates the generation, transport, storage, treatment, and disposal of solid wastes. Regulations at 40 CFR 258 govern preparedness and prevention, closure, and post-closure at municipal solid waste landfills.	Performance of this alternative will be evaluated to determine compliance with the substantive requirements of federal solid waste regulations.
	Hazardous waste landfill construction, operation, closure, and post-closure	Resource Conservation and Recovery Act (RCRA) [Subtitle C, 40 CFR 260,264]	Relevant and Appropriate	RCRA Subtitle C regulates the generation, transport, storage, treatment, and disposal of hazardous wastes. Regulations at 40 CFR 264 govern preparedness and prevention, closure, and post-closure at landfills.	This alternative includes components to meet the substantive requirements of these regulations.
State Regulatory Authority	Solid waste landfill construction, operation, closure, and post-closure.	Massachusetts Solid Waste Management Regulations [310 CMR 19.100]	Applicable	These regulations outline the requirements for construction, operation, closure, and post-closure at solid waste management facilities in the Commonwealth of Massachusetts.	This alternative includes components to meet the substantive requirements of these regulations.
	Hazardous waste landfill construction, operation, closure, and post-closure	Massachusetts Hazardous Waste Regulations [310 CMR 30.00]	Relevant and Appropriate	Regulates handling, storage, treatment, disposal, and record keeping at hazardous waste facilities.	Performance of this alternative will be evaluated to determine compliance with the substantive requirements of Massachusetts hazardous waste regulations.

Notes:

DOI =
FWS =
NMFS =

TABLE 5–14
COST SUMMARY TABLE
ALTERNATIVE SHL–10: INSTALLATION OF RCRA CAP

FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ITEM	COST
DIRECT COSTS	
Site preparation and mobilization	$281,000
Installation of RCRA Cap	$14,817,000
Institutional controls and educational programs	$13,000
TOTAL DIRECT COST	$15,111,000
INDIRECT COSTS	
Health and Safety @ 5% of total direct cost	$756,000
Legal, Administrative, Permitting @ 5% of total direct cost	$756,000
Engineering @ 10% of total direct cost	$1,511,000
Services during construction @ 10% of total direct cost	$1,511,000
TOTAL INDIRECT COST	$4,534,000
TOTAL CAPITAL (DIRECT AND INDIRECT) COST	$19,645,000
OPERATION AND MAINTENANCE COSTS	
Total annual operating and maintenance costs	$84,000
TOTAL PRESENT WORTH OF O&M COSTS (5% FOR 30 YEARS)	$1,291,000
TOTAL PRESENT WORTH OF ALTERNATIVE	$20,936,000

SECTION 6.0

TABLE 6-1
COMPARATIVE ANALYSIS SUMMARY

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ASSESSMENT FACTORS	ALTERNATIVE SHL-1: NO ACTION	ALTERNATIVE SHL-2: LIMITED ACTION	ALTERNATIVES SHL-5A AND B: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE	ALTERNATIVES SHL-9A AND B: COLLECTION/ DISCHARGE TO POTW	ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
Overall Protection of Human Health and the Environment					
Human Health	· Relies on cover system performance and its predicted effects on groundwater flow to protect human receptors.	· Protection of human health provided through implementation of institutional controls and performance of cover system.	· Protection of human health provided through implementation of institutional controls, extraction of groundwater, and performance of cover system.	· Protection of human health provided through implementation of institutional controls, extraction of groundwater, and performance of cover system.	· Protection of human health provided through implementation of institutional controls and performance of cover system.
Environment	· No ecological exposures identified. Groundwater modeling suggests recent capping would divert flow away from northern portions of Plow Shop Pond.	· No ecological exposures identified. Groundwater modeling suggests recent capping would divert flow away from northern portions of Plow Shop Pond.	· Would extract groundwater, preventing it from leaving the site.	· Would extract groundwater, preventing it from leaving the site.	· No ecological exposures identified. Groundwater modeling suggests capping would divert flow away from northern portions of Plow Shop Pond.
Compliance with ARARs					
Location-Specific	· No actions taken that would trigger ARARs.	· Activities will be conducted/ altered to comply with wetlands and floodplain ARARs. · Site activities would be planned to prevent adverse effects on the Grasshopper Sparrow and its habitat.	· Activities will be conducted/altered to comply with wetlands and floodplain ARARs. · Site activities would be planned to prevent adverse effects on the Grasshopper Sparrow and its habitat.	· Activities will be conducted/altered to comply with wetlands and floodplain ARARs. · Site activities would be planned to prevent adverse effects on the Grasshopper Sparrow and its habitat.	· Activities will be conducted/altered to comply with wetlands and floodplain ARARs. · Site activities would destroy any nesting areas of Grasshopper Sparrow.
Chemical-Specific	· No activities will occur to evaluate compliance with chemical-specific ARARs or PRGs.	· Long-term groundwater monitoring will be implemented to evaluate compliance with chemical-specific ARARs and PRGs.	· Long-term groundwater monitoring will be implemented to evaluate compliance with chemical-specific ARARs and PRGs.	· Long-term groundwater monitoring will be implemented to evaluate compliance with chemical-specific ARARs and PRGs.	· Long-term groundwater monitoring will be implemented to evaluate compliance with chemical-specific ARARs and PRGs.

(continued)

TABLE 6-1
COMPARATIVE ANALYSIS SUMMARY

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ASSESSMENT FACTORS	ALTERNATIVE SHL-1: NO ACTION	ALTERNATIVE SHL-2: LIMITED ACTION	ALTERNATIVES SHL-5A AND B: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE	ALTERNATIVES SHL-9A AND B: COLLECTION/ DISCHARGE TO POTW	ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
		· Long-term landfill gas monitoring will be implemented to evaluate compliance with Ambient Air Quality Standards. · MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.	· Long-term landfill gas monitoring will be implemented to evaluate compliance with Ambient Air Quality Standards. · Groundwater exceeding PRGs would be extracted and treated prior to exiting the site. · Would capture groundwater prior to leaving site and potentially discharging to nearby wetlands and surface water. · Groundwater discharge would be treated and monitored to prevent AWQC exceedances in Nonacoicus Brook.	· Long-term landfill gas monitoring will be implemented to evaluate compliance with Ambient Air Quality Standards. · Groundwater exceeding PRGs would be extracted prior to leaving the site and discharged to the Town of Ayer POTW. · Would capture groundwater prior to leaving site and potentially discharging to nearby wetlands and surface water.	· Long-term landfill gas monitoring will be implemented to evaluate compliance with Ambient Air Quality Standards. · MCLs will be used to evaluate the performance of this alternative. If MCLs are exceeded, the interim remedy will be re-evaluated.
Action-Specific	· Complies with cover system requirements of 310 CMR 19.000. · Meets cover system performance standards of 310 CMR 30.000, 40 CFR 264, and 40 CFR 258.	· Complies with cover system requirements of 310 CMR 19.000. · Meets cover system performance standards of 310 CMR 30.000, 40 CFR 264, and 40 CFR 258.	· Complies with cover system requirements of 310 CMR 19.000. · Meets cover system performance standards of 310 CMR 30.000, 40 CFR 264, and 40 CFR 258.	· Complies with cover system requirements of 310 CMR 19.000. · Meets cover system performance standards of 310 CMR 30.000, 40 CFR 264, and 40 CFR 258.	· Complies with cover system requirements of 310 CMR 19.000. · Meets cover system performance standards of 310 CMR 30.000, 40 CFR 264, and 40 CFR 258.

(continued)

TABLE 6-1
COMPARATIVE ANALYSIS SUMMARY

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ASSESSMENT FACTORS	ALTERNATIVE SHL-1: NO ACTION	ALTERNATIVE SHL-2: LIMITED ACTION	ALTERNATIVES SHL-5A AND B: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE	ALTERNATIVES SHL-9A AND B: COLLECTION/ DISCHARGE TO POTW	ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
	· Varies from USEPA design guidance for hazardous waste landfill covers. · Landfill post-closure requirements would not be met.	· Varies from USEPA design guidance for hazardous waste landfill covers. · Landfill post-closure requirements would be met.	· Varies from USEPA design guidance for hazardous waste landfill covers. · Landfill post-closure requirements would be met. · Would be required to meet substantive requirements of a NPDES permit to discharge to Nonacoicus Brook. · Would be required to meet substantive requirements of a USACE permit, MADEP license, and Massachusetts water quality certification to construct discharge line to Nonacoicus Brook. · Disposal of treatment residuals would be required to meet RCRA regulations.	· Varies from USEPA design guidance for hazardous waste landfill covers. · Landfill post-closure requirements would be met. · Discharge to POTW required to meet CWA General Pretreatment Requirements.	· Meets USEPA design guidance for hazardous waste landfill covers. · Landfill post-closure requirements would be met.
Long-Term Effectiveness and Permanence					
Adequacy and Reliability of Controls	· No actions taken to evaluate long-term effectiveness.	· Post-closure and long-term groundwater monitoring would evaluate long-term effectiveness.	· Post-closure and long-term groundwater monitoring would evaluate long-term effectiveness.	· Post-closure and long-term groundwater monitoring would evaluate long-term effectiveness.	· Post-closure and long-term groundwater monitoring would evaluate long-term effectiveness.

(continued)

TABLE 6-1
COMPARATIVE ANALYSIS SUMMARY

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ASSESSMENT FACTORS	ALTERNATIVE SHL-1: NO ACTION	ALTERNATIVE SHL-2: LIMITED ACTION	ALTERNATIVES SHL-5A AND B: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE	ALTERNATIVES SHL-9A AND B: COLLECTION/ DISCHARGE TO POTW	ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
Magnitude of Residual Risk	· Landfill leachate and waste may contaminate aquifer underlying landfill if cover system is not effective.	· Landfill leachate and waste may contaminate aquifer underlying landfill if cover system is not effective.	· Landfill leachate and waste may contaminate aquifer underlying landfill if cover system is not effective. · Pre-design hydrogeological investigation would allow more effective design of groundwater extraction system.	· Landfill leachate and waste may contaminate aquifer underlying landfill if cover system is not effective. · Pre-design hydrogeological investigation would allow more effective design of groundwater extraction system.	· Landfill leachate and waste may contaminate aquifer underlying landfill if cover system is not effective.
Reduction of Toxicity, Mobility, or Volume through Treatment					
Reduction of Toxicity, Mobility, or Volume	· None	· None	· Mobility reduced by extracting groundwater prior to leaving the site. · Volume reduced by generating concentrated waste on carbon and filter cake.	· Mobility reduced by extracting groundwater prior to leaving the site.	· None
Irreversible Treatment	· Not applicable, no treatment.	· Not applicable, no treatment.	· Treatment irreversible.	· Treatment at POTW irreversible.	· Not applicable, no treatment.

(continued)

TABLE 6-1
COMPARATIVE ANALYSIS SUMMARY

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ASSESSMENT FACTORS	ALTERNATIVE SHL-1: NO ACTION	ALTERNATIVE SHL-2: LIMITED ACTION	ALTERNATIVES SHL-5A AND B: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE	ALTERNATIVES SHL-9A AND B: COLLECTION/ DISCHARGE TO POTW	ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
Type and Quantity of Residuals Remaining after Treatment	· Not applicable.	· Not applicable.	· Treatment residuals include: Filter cake - estimated 125 lbs/day. Regeneration concentrate - 75 gal/2 days. · Spent activated carbon.	· Treatment residuals (i.e., sludge) would be generated at the POTW.	· Not applicable.
Statutory Preference for Treatment	· Not satisfied.	· Not satisfied.	· Satisfied.	· Satisfied.	· Not satisfied.
Short-Term Effectiveness					
Community Protection	· No actions taken that would pose short-term risk.	· Risk to community minimized through monitoring.	· Transport of treatment residuals would follow DOT and RCRA regulations to protect community. · Dust controls utilized during intrusive activities.	· Dust controls utilized during intrusive activities.	· Risk to community minimized through monitoring. · Increased truck traffic presents potential risk.
Worker Protection	· No actions taken that would pose short-term risk.	· All site activities would require following a HASP.	· All site activities would require following a HASP.	· All site activities would require following a HASP.	· All site activities would require following a HASP.
Environmental Impacts	· No actions taken that would pose short-term risk.	· All site activities would be performed to minimize effects on the Grasshopper Sparrow and its habitat.	· All site activities would be performed to minimize effects on the Grasshopper Sparrow and its habitat.	· All site activities would be performed to minimize effects on the Grass-hopper Sparrow and its habitat.	· Any existing nesting areas of Grasshopper Sparrow would be destroyed. · Workers exposed to risks construction activities.

(continued)

TABLE 6-1
COMPARATIVE ANALYSIS SUMMARY

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ASSESSMENT FACTORS	ALTERNATIVE SHL-1: NO ACTION	ALTERNATIVE SHL-2: LIMITED ACTION	ALTERNATIVES SHL-5A AND B: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE	ALTERNATIVES SHL-9A AND B: COLLECTION/ DISCHARGE TO POTW	ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
Time Until Action is Complete	· No action implemented.	· Up to 12 months required for engineering evaluations, design, and construction.	· Pumping would continue until PRGs met. Since leachate and landfill waste would not be eliminated, pumping could continue indefinitely. · Up to 18 months required for pre-design studies, design, and construction.	· Pumping would continue until PRGs met. Since leachate and landfill waste would not be eliminated, pumping could continue indefinitely. · Up to 15 months required for pre-design, study, and construction.	· Up to 3 years for design and construction.
Implementability					
Ability to Construct and Operate	· No construction or operation needed.	· Construction and operation would follow conventional practice.	· Vendors available to construct extraction and treatment systems. · Oversight required during operation.	· Vendors available to construct extraction and discharge systems. · Minimal oversight required during operation.	· Construction and operation would follow conventional practice.
Ease of Undertaking Additional Action	· Would not interfere with future actions.	· Would not interfere with future actions.	· Would not interfere with future actions.	· Would not interfere with future actions.	· Would not interfere with future actions.
Ability to Monitor Effectiveness	· Effectiveness would not be monitored.	· Effectiveness would be monitored by monitoring groundwater.	· Effectiveness would be monitored by monitoring groundwater.	· Effectiveness would be monitored by monitoring groundwater.	· Effectiveness would be monitored by monitoring groundwater.
Ability to Obtain Approvals and Coordinate with Other Agencies	· No approvals or coordination required.	· Institutional controls would require cooperation by the Town of Ayer.	· Institutional controls would require cooperation by the Town of Ayer. · Would be required to meet substantive requirements of NPDES permit to discharge to Nonacoicus Brook.	· Institutional controls would require cooperation by the Town of Ayer. · Would require long-term discharge agreement between the U.S. Army and the Town of Ayer POTW.	· Institutional controls would require cooperation by the Town of Ayer.

(continued)

TABLE 6-1
COMPARATIVE ANALYSIS SUMMARY

SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ASSESSMENT FACTORS	ALTERNATIVE SHL-1: NO ACTION	ALTERNATIVE SHL-2: LIMITED ACTION	ALTERNATIVES SHL-5A AND B: COLLECTION/ION EXCHANGE TREATMENT/SURFACE WATER DISCHARGE	ALTERNATIVES SHL-9A AND B: COLLECTION/ DISCHARGE TO POTW	ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
			· Would be required to meet substantive requirements of USACE permit, MADEP license, and Massachusetts Water Quality Certification to construct discharge.		
Availability of Services and Capacity	· No services required.	· Sampling and analytical services available. · Design and construction services available locally or regionally.	· Sampling and analytical services available. · Off-site disposal of treatment residuals required.	· Sampling and analytical services available. · Design and construction services available locally or regionally.	· Sampling and analytical services available. · Design and construction services available locally or regionally.
Availability of Equipment Specialists and Materials	· No equipment, specialists, or materials needed.	· Available locally or regionally.	· Available locally or regionally.	· Available locally or regionally.	· Available locally or regionally.
Availability of Technologies	· Not applicable.	· Groundwater monitoring is a common technology.	· Groundwater monitoring is a common technology. · Ion exchange is a common technology for treatment of inorganics.	· Groundwater monitoring is a common technology.	· Groundwater monitoring is a common technology. · Capping technology is readily implementable.
Cost					
Capital Cost	$0	$928,000	$2,577,000	$1,184,000	$19,645,000
Annual O&M Cost	$0	$84,000	$426,000	$175,000	$84,000
Present Worth Cost (based on a 30-year period)	$0	$2,219,000	$9,126,000	$3,874,000	$20,936,000

APPENDIX A

APPENDIX A

GROUNDWATER MODEL OF SHEPLEY'S HILL LANDFILL AREA

Ground Water Model of the Shepley's Hill Landfill Area

Prepared for:

ABB Environmental Services
110 Free St.
Portland, ME, 04101

by

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3458 Ellicott Center Drive #101
Ellicott City, MD, 21043

July 15, 1994

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I. INTRODUCTION

Engineering Technologies Associates, Inc. (ETA) has been retained by ABB Environmental Services (ABB-ES) to develop a ground water model of the Shepley's Hill landfill area at Fort Devens, Massachusetts. The model will assist in the ongoing feasibility study (FS) of the site. The work is being conducted under ABB-ES subcontract 93-24-001G as part of a project for the U.S. Army Environmental Center (DAAA15-91-D-0008/0004).

II. OBJECTIVE

The objective of the model is to simulate the ground water flow beneath the Fort Devens Shepley's Hill landfill and to evaluate the effectiveness of various alternative remedial actions on controlling ground water contamination.

III. BACKGROUND

Shepley's Hill landfill occupies approximately 84 acres in the northeast corner of the Main Post at Fort Devens. Wastes potentially disposed of in the landfill include incinerator ash, glass, spent shell casings, flammable fluids, and asbestos (ABB-ES, 1993).

Groundwater at the landfill is contaminated with low concentrations of volatile organic compounds and metals of which aluminum, arsenic, and manganese are the most significant. Based on the pattern of arsenic in sediment in Plow Shop Pond, the landfill caused the contamination of the ground water flowing into the pond (ABB-ES, 1993).

IV. CONCEPTUAL MODEL OF GROUND WATER FLOW

Ground water at the Shepley's Hill landfill flows east and north towards Plow Shop Pond and Nonacoicus Brook. The principal aquifer at the site is the overburden which consists of sandy glacial outwash. Small amounts of ground water flow through fractures in the bedrock, following essentially the same flow pattern as ground water in the overburden. A ground water divide runs along the crest of Shepley's Hill and through the DRMO yard to the south. Recharge occurs throughout the area except where the landfill was capped, or buildings, roads, and parking lots have created other impervious areas.

The landfill was capped in stages from 1986 to 1992. The landfill cap prevents recharge to the water table aquifer and results in declining water table elevations.

By calibrating a numerical model of ground water flow to the water table decline in this period, the future decline may be predicted. A declining water table will reduce the ground water contamination reaching Plow Shop Pond.

V. MODEL DESIGN

A. MODFLOWP

MODFLOWP is a version of the U.S. Geological Survey Modular, Three-Dimensional, Finite-difference, Ground-Water Flow Model (MODFLOW) which can be used to estimate parameters by nonlinear regression. Parameters are estimated by minimizing a weighted least-squares objective function by the modified Gauss-Newton method or by a conjugate-direction method. The following parameters may be estimated: transmissivity and storage coefficient of confined layers; hydraulic conductivity and specific yield of unconfined layers; vertical leakance; vertical anisotropy (used to calculate vertical leakance); horizontal anisotropy; hydraulic conductances of rivers, streams, drains and general head boundaries; recharge, maximum evapotranspiration, pumpage, and constant head boundary elevations. Spatial variation in parameters is defined by the user. Data used to estimate parameters can include existing parameter estimates, observed hydraulic heads and observed stream gain and loss. Model output includes statistics for analyzing parameter estimates; these statistics may be used to quantify the reliability of the resulting model.

MODFLOWP was selected for the modeling of the Shepley's Hill landfill because of the relative homogeneity of the glacial outwash, the quantity of monitoring well water level data available, and the more objective nature of the resulting calibration. The original intent was to use MODFLOWP to estimate the hydraulic conductivities, storage factors (specific yield for the water table aquifer and storage coefficient for the bedrock), and vertical leakance using a nonlinear regression procedure. This intention was not fulfilled for a number of reasons. First, there were very few monitoring wells in the bedrock. This lack of data made attempts at automatic calibration of the bedrock aquifer parameters futile. Second, MODFLOWP and the preconditioned conjugate gradient solver package (PCG2) were not able to converge when overburden aquifer transmissivity was a parameter. This is a known problem with MODFLOWP in a highly heterogeneous aquifer (Hill, 1992, p.227). MODFLOWP was still useful for model calibration, however, because it calculates statistics that compare the model to the observed data.

One change was made to MODFLOWP for this project. When using MODFLOWP for transient problems using the parameter estimation package, an initial steady state time step (time step zero) is added to the simulation. As will

be explained later, the model was calibrated in successive transient periods. In order to successfully perform the calibration, MODFLOWP was modified to keep the initial time step (0) at the same length as the first input transient step.

B. Grid and Boundaries

Figure 1 shows the model grid. There were 107 columns and 97 rows at a 40 foot equal spacing. Figure 1 also shows the boundaries of the model relative to the physical features of the site. The crest of Shepley's Hill was a noflow boundary. Plow Shop and Grove Ponds were represented as constant head boundaries. The remaining boundaries were initially constant head boundaries, although, as explained later, the northern boundary was changed during the calibration.

Model boundaries were far enough from the landfill cap to have no significant impact on the simulation of the effect of the cap on the ground water flow. Where no natural boundary, watershed divide or surface water body, existed within the model grid, constant head boundaries were created based on the calibrated results of a previous regional modeling effort (ETA, 1993).

The grid extends to the south and east beyond the current watershed divide. This was intentionally done to allow the watershed divide to potentially move to the east as the water table beneath the Shepley's Hill landfill falls in response to capping. Allowing the watershed divide to move over time results in a more realistic model.

The grid was aligned with the State Plane coordinate system to expedite the preparation of model input. A model with fewer inactive grids could have been developed by rotating the grid to the east so that the rows were aligned with the Shepley's Hill watershed divide. The project schedule dictated a less efficient configuration that was easier and quicker to develop.

During the calibration of the model, the northern constant head boundary (row 1) was changed to a general head boundary. The monitoring wells on the north side of the landfill cap did not fluctuate enough because they were too close to a constant head boundary. The overburden aquifer constant head boundary was replaced by a general head boundary. The bedrock aquifer constant head boundary was replaced by a noflow boundary. The general head boundary assumed a constant head elevation of 213 feet above mean sea level that was 200 feet north of row 1 connected to the model by a transmissivity of 4000 ft^2/day. This change permitted heads to fluctuate north of the landfill, and the calibration to be improved.

This general head boundary represents Nonacoicus Brook and the associated wetlands that exist to the north of the Shepley's Hill landfill. Nonacoicus Brook is

a perennial stream that is a sink for ground water flow in the overburden. Downstream from Plow Shop Pond, Nonacoicus Brook is surrounded by wetlands. These wetlands are an expression of the water table in the overburden. For the purposes of this modeling study, simulating Nonacoicus Brook and the associated wetlands as a constant head boundary is a reasonable approximation.

C. AQUIFER DELINEATION

Two layers were used to simulate the ground water flow at the Shepley's Hill landfill, the overburden and bedrock. ABB-ES developed a bedrock elevation map which was digitized into AUTOCAD and the contour points extracted into a file by ETA. The Golden Software SURFER program was then used to grid these data. This gridded data then became a model input file. Figure 2 shows the results of the reinterpolation of the bedrock map.

During the calibration, both layers of the model were simulated as constant transmissivity layers. In a water table or convertible aquifer layer, transmissivity is calculated at each iteration as the product of hydraulic conductivity and saturated thickness. In a constant transmissivity layer, transmissivities are calculated outside the model for each grid cell the same way, and then input to the model and remain constant throughout the simulation. Then transmissivities were adjusted, a new water table calculated, and transmissivities recalculated, and reinput to the model. The calibration procedure is described in Section V.G. of this report.

The model was converted back to a water table aquifer for simulating scenarios. The bedrock aquifer was assumed to have a thickness of 50 feet for these scenarios. Ground water flow through the bedrock is through fractures in the rock. Fracturing is more common close to the top of the bedrock where weathering occurs. The choice of 50 feet as the thickness of flow was a professional judgment that had no impact on the calibration or the alternative evaluation because:

- ground water flow through the bedrock aquifer is insignificant in comparison to the flow through the overburden aquifer; and

- the bedrock aquifer is confined under most of the modeled area.

The conversion of the overburden to a water table aquifer was used to identify areas of little or no saturation in the overburden aquifer.

D. Recharge

Potential monthly recharge was calculated as a function of precipitation and average monthly potential evapotranspiration. Actual recharge for each grid cell

was calculated as a function of the potential recharge and land cover. On the sandy surface soils that are typical for the site, the full potential recharge was applied. Where the landfill has been capped with an impermeable membrane, recharge was taken as zero. Buildings, roads, and bedrock outcrops reduced recharge to an intermediate proportion.

Daily precipitation data were obtained from the National Climatic Data Center for the period from January 1986 to April 1993 for six cooperative weather stations that surround Fort Devens. These stations were: Ashburnham, Framingham, Lowell, Natick, Pepperell, and the Worcester Airport. Precipitation data were also obtained from Fort Devens. A weather station was operated at the Moore Army Airfield until February 1993. These precipitation readings were typically not over a full 24 hour period, however, and were not used in developing monthly precipitation estimates for the Shepley's Hill Landfill.

A computer program was written to read in daily precipitation data from the six stations, calculate a daily weighted average precipitation, and sum monthly and yearly totals. Weighing factors were calculated for each day to exclude missing data. Although six stations were used in the average, it was rare to have data from more than four of them for any given day. The original intention was to develop station weights as a function of the distance of the station from Fort Devens. Testing of the program indicated that the resulting averages were insensitive to the assigned station weights; similar results were calculated for different weighing schemes. This result occurred because of climatic similarity between stations and because of the missing data. When only two stations were used in calculating the daily weighted average, they were both important. Because the calculated averages were insensitive to the weights, equal weights were used in the calculations. Calculated yearly weighted averaged precipitation was:

1986	49.2 inches
1987	45.2 inches
1988	42.0 inches
1989	52.6 inches
1990	51.6 inches
1991	50.1 inches
1992	43.6 inches

Only a partial year of data for 1993 were available so it was not possible to calculate the yearly precipitation. Figure 3 shows the hydrograph of monthly precipitation for the calibration period.

Potential recharge was calculated from these monthly precipitation values by subtracting evapotranspiration. This recharge value was used in model grids where there were flat, sandy soils and no impervious area. Evapotranspiration was calculated using the Blaney-Criddle formula. The resulting potential evapotranspiration was:

Month	ET (inches)
Jan	0.81
Feb	0.99
March	2.14
April	3.55
May	5.26
June	6.28
July	6.84
Aug	6.11
Sept	4.52
Oct	3.14
Nov	1.81
Dec	1.01

If the calculated potential recharge was less than one inch, recharge was assumed to be one inch for the month. This convention was an attempt to account for the fact that precipitation is not evenly spread over the month, but occurs on several days, so recharge occurs even if monthly evapotranspiration is greater than precipitation.

The one inch of recharge in the summer months accounts for precipitation greater than the soil moisture deficit percolating below the root zone and becoming ground water recharge even in months where precipitation is less than potential evapotranspiration. While qualitatively this concept is fairly straightforward, to quantify the complex relationship between evapotranspiration, precipitation and infiltration rate is difficult. An unsaturated zone numerical model could potentially calculate recharge, but given the wide variability in infiltration rates due to soil heterogeneity, and macropores, even numerical models of the unsaturated zone fail to yield accurate recharge estimates. Recharge occurs in many climates where potential evapotranspiration is greater than precipitation every month. Recharge and the resulting meteoric water resource in these climates occur only because some precipitation events cause infiltration to percolate below the root zone before evapotranspiration can take place. The estimate of one inch is a professional judgment to recognize this complex phenomena.

The resulting monthly potential recharge values were further reduced by the impervious area of the land cover. The capping of the landfill with an impermeable membrane from 1986 to 1992 was represented in four stages: 1986, 1987, 1989, and 1991. The landfill cap was assumed to prevent any recharge from occurring in these areas.

A visual inspection of the landfill in December of 1993 indicated that substantial amounts of runoff from the cap and Shepley's Hill travel down the drainage ditch on the northwest side of the fill and then infiltrate into the sandy soil at the north end of the landfill. This phenomena was simulated by multiplying the potential recharge values by five in this area. This area was directly north of the landfill cap in rows 5 through 8 and columns 50 through 58. It covered an area of 57600 ft^2. A second infiltration area was at the southeast corner of the landfill cap. This area was in row 70 and columns 60 through 65 and was simulated by multiplying the potential recharge values by two. It covered an area of 9600 ft.

Recharge was reduced to one-half the potential value on the Shepley's Hill bedrock outcrop. Less infiltration and recharge was assumed to occur on the rock. This is a common assumption in the northeastern United States (Lyford and Cohen, 1988; Morrisey, Randall and Williams, 1988). Parts of Shepley's Hill were assumed not contain a saturated bedrock aquifer (the bedrock transmissivity was assumed to apply over the upper 50 feet of bedrock thickness).

The runoff from Shepley's Hill was assumed to recharge at the edge of the overburden aquifer. The first active overburden aquifer cell in each row on the east side of Shepley's Hill received recharge at a rate of 1.5 times the potential recharge rate.

In the southern area of the model, there was considerable development including roads, parking lots and pavement. Land use mapping was obtained from the Massachusetts Division of Environmental Protection Geographic Information System. There were six composite categories of land use that were summarized by model grid cell. Each land use was assigned a fraction of impervious area.

wetland	1.00
water	1.00
residential	0.30
commercial	0.65
urban open	0.50
open land	0.00

Recharge was assigned to model grid cells by subtracting the impervious area fraction from one and multiplying by the potential recharge as previously determined.

During the calibration, the urban open area impervious area fraction was changed from 0.5 to 0.4. Model predicted water levels were below observed levels in the southern model area where the railroad is. The railroad does not contribute any appreciable impervious area, so the impervious area fraction area was lowered.

A constant rate of recharge was assumed for the post calibration simulation. The potential recharge rate was calculated by subtracting potential evapotranspiration from average monthly precipitation and summing the total for the year. In any month when average monthly precipitation minus potential evapotranspiration was less than one inch, recharge was assumed to be one inch for the month.

Month	Average Precipitation (in)	Potential Evapotrans-piration (in)	Recharge (in)
Jan	3.79	0.81	2.98
Feb	3.11	0.99	2.12
March	3.95	2.14	1.81
April	3.71	3.55	1.00
May	3.54	5.26	1.00
June	3.60	6.28	1.00
July	3.44	6.84	1.00
Aug	3.68	6.11	1.00
Sept	3.86	4.52	1.00
Oct	3.31	3.14	1.00
Nov	4.15	1.81	2.34
Dec	3.88	1.01	2.87
Total	44.02	42.46	19.12

During the calibration process, the water table dropped and grid cells became unsaturated in both the bedrock and overburden aquifers on the flanks of Shepley's Hill. These grid cells and the recharge assigned to them were effectively removed from model simulations. To account for this effect, recharge as amplified by adding up the dry grid cells in each row of the model from the noflow boundary at the Shepley's Hill watershed divide to the first active grid cell in the bedrock aquifer. All of the recharge lost in the dry grid cells, up to a maximum of five grids, was assumed to recharge the aquifer at first active grid cell in each row.

E. Initial Heads

The first calibration efforts used the steady state heads from the previous regional modeling effort (ETA, 1993) as the initial position of the potentiometric surface

in 1986. These heads were interpolated to the grid centers of the model. Adjustments to these heads were made at constant head boundaries at Plow Shop and Grove Pond; a constant elevation of 216.9 was set at this boundary. This was the average elevation of Grove and Plow Shop Ponds during 1992 and 1993 (stage measurements as reported in IRDIMIS). The southwestern and southern constant head boundary elevations were also adjusted. The regional model used a 2000-foot grid spacing, so it did not adequately simulate the watershed boundary between the Shepley's Hill Landfill and the Willow Creek watershed. This boundary is defined by bedrock outcrops including Shepley's Hill. The south and southwestern constant head boundaries were adjusted to reflect the actual water table elevations.

The calibration effort indicated that the calibration was sensitive to the initial heads assumed. There was inadequate data to map the water table in 1986 before the landfill was capped. The previous regional model (ETA, 1993) was run without the landfill cap (changing recharge values in five grid cells), but the result differed only slightly from the regional modeling with the landfill cap. Finally, a reasonable set of initial heads were simulated by running the model to an approximate steady state position by removing the landfill cap and using a recharge rate of 19 inches/year.

F. Initial Aquifer Parameter Values

Initial estimates of aquifer parameters were based on the results of the previous Fort Devens regional ground water flow modeling and professional judgment. Hydraulic conductivity of the overburden aquifer was estimated to be 50 ft/day based on the calibrated regional model (ETA, 1993). The specific yield of the overburden aquifer was initially estimated at 0.1, which is a typical value for sand. The transmissivity of the bedrock aquifer was estimated to be 72 ft^2/day based on the calibrated regional model (ETA, 1993). The storage coefficient of the bedrock aquifer was estimated at 0.0001, a typical value for a confined aquifer. The leakance between aquifers was estimated at 0.01 day^{-1}, based on the calibrated regional model (ETA, 1993). These values were altered during the calibration.

G. Calibration

The targets for the calibration of the model were observed monitoring well water levels from 1986 through March 1993. As explained in the recharge section of this report, precipitation data were only available through April of 1993. The vast majority of the available data were from 1991 through 1993; only a few measurements were available from 1986 through 1990. The calibration simulations were therefore conducted in two steps. The first simulation was from 1986 through 1990 with monthly stress periods. Only qualitative comparisons

were made between the model results and the monitoring well data in this time period. The second simulation was from 1991 through April 1993. The parameter estimation package of MODFLOWP was used to statistically compare model results and the monitoring well data in this time period.

No steady state calibration was conducted because there were no data from any time period that would approximate a steady state condition. The hypothesis being tested with the model was that the landfill cap would prevent recharge to the overburden and the water table would decline. Construction of the cap began in 1986 and completed in 1992. There were insufficient data available prior to the construction of the cap to calibrate the model at steady state.

A number of problems were encountered during the calibration. For many of the initial parameter sets, the model failed to converge. The overburden aquifer was unsaturated or had very thin saturated thicknesses in a number of areas adjacent to bedrock outcrops. When the overburden aquifer was simulated as a water table aquifer under transient conditions, grid cells became dry during periods of low recharge. When grid cells dry up in MODFLOW (and MODFLOWP) they are dry for the remainder of the simulation, and the aquifer continually shrinks during the simulations. This situation was undesirable for the calibration. One potential solution to this problem is to rewet dry nodes during the simulation. There is a modified version of the Block Centered Flow Package (BCF2) (McDonald et al, 1991) that allows cells to rewet during simulations. This package of FORTRAN code was compiled and tried, but the problem become highly nonlinear and did not converge. A second solution is to linearize the model by converting water table layers to constant transmissivity layers. The methodology for this conversion was previously described in Section II.C. of this report. The linearization resulted in a robust model that converged without difficulty, although it added an iterative step, the conversion from water table to constant transmissivity at intervals in the calibration process.

The original intent of using MODFLOWP on the project was to use the parameter estimation feature of MODFLOWP to calibrate the model. This was not possible because of the extreme variation in saturated thickness from grid to grid resulting in large variations in transmissivity even when the aquifers were linearized. This variation resulted in a matrix that the preconditioned conjugate gradient solver package (PCG2) was unable to solve because it was not diagonally dominant. This is a known shortcoming of the MODFLOWP model (Hill, 1992, p. 227). The preconditioned conjugate gradient solver package (PCG2) was able to solve the matrix when the parameter estimation package was not used.

Calibration proceeded using MODFLOWP to produce the calibration statistics for the model. The hydraulic conductivity of the overburden aquifer was reduced to 40 ft/day. The transmissivity of the bedrock aquifer was reduced to 36 ft^2/day.

The specific yield of the overburden was reduced to 0.05, although it likely that the correct specific yield is not this small.

The low values of specific yield were an artifact of the transient calibration. The model simulated the monthly average recharge to the aquifer. Water levels were measured at a particular day and time. These measured water levels may have been preceded by a day of precipitation or by a week of dry weather. Given that water levels at the Shepley's Hill landfill respond rapidly to precipitation events, one would not expect that monitoring well water levels would match simulated monthly average water levels. The reduction in specific yield was an attempt to calibrate the model.

The most difficult part of the model to calibrate was near the bedrock outcrops around the DRMO yard. Numerous lithologic logs and well records were reviewed and the mapping appears consistent with interpretation of the logs. No gross errors in bedrock mapping were made. Bedrock is at shallow depths throughout this area and overburden saturated thickness is small and/or nonexistent. The model, when simulating the overburden as a water table aquifer and the bedrock as a convertible (confined or water table) aquifer, constantly dried up in this area. The pattern of inactive grid cells was adjusted manually to attempt to leave channels of overburden for the ground water to flow through around the bedrock outcrops. Ultimately, this attempt was unsuccessful. The Willow Creek and Plow Shop Pond/Grove Pond/ Nonacoicus Brook watersheds are effectively separated by a bedrock high with thin or no saturation of the overburden aquifer. This was an important revision of the conceptual model where it was assumed that the watershed boundary would move in response to the lowering of the water levels beneath at the landfill.

Given the large difference in hydraulic conductivity between the overburden and the bedrock, the distribution of saturated overburden thickness was one of the most important factors in the model calibration. Areas with thinly saturated overburden typically ran dry in model simulations assuming a water table aquifer in the overburden. When this occurred, there was an immediate steepening of the gradient in that grid cell. The calibration was conducted using a constant transmissivity assumption in the overburden aquifer with thin saturated thicknesses in grid cells that typically ran dry under water table conditions. Thus, one of the critical model parameters was the saturated thickness, which is a function of the simulated water table elevation and the bedrock elevation.

The statistical results of the calibration are shown in Appendix A. The weighted residual from 341 monitoring well observations from 1991 to 1993 was 1.0 feet. The weighted residual is the same as the mean difference between observed and simulated water levels since all measurements were given the same weight. Figure 4 shows the bedrock aquifer heads predicted by the model at the end of

the calibration period (April 1993). Bedrock aquifer heads were very similar to the overburden aquifer heads where both layers were active. The plots for the overburden and bedrock aquifers were similar. Figure 5 shows the observed (interpreted under the landfill where there are not data) piezometric surface (ABB-ES, 1993). The observed piezometric surface does not distinguish between the overburden and bedrock aquifers, because water levels in overburden and bedrock monitoring wells indicate very small vertical gradients (as in the model). The modeled and observed surfaces are similar except for directly under the landfill (where there are no monitoring wells and measurements) where the water table is simulated as substantially lower than the interpreted water table (see Figure 3-7 in ABB-ES, 1993).

Figures 6 through 9 show plots of water levels versus time for both monitoring well observations and heads simulated by the model. The model response is generally correct with most trends reproduced, however, the model response is muted. The inability to simulate the full response of the aquifer to precipitation events is a consequence of the timing of recharge. In the model, recharge was calculated for each month and applied equally over the month in two time steps. In reality, precipitation falls in a few days of the month and rapidly infiltrates causing the water table to rise. In ETA's pump testing of monitoring well SHM-93-10C in November, a thunderstorm occurred. Monitoring well SHL-10 responded almost immediately and rose 0.2 foot in minutes. When the storm was over, the water level fell almost as fast. It is not possible to accurately simulate daily fluctuations of the water table with monthly recharges. The overburden specific yield was reduced to 0.05 in an attempt to improve model responsiveness.

VI. SCENARIOS

A. Base Case

One of the objectives of the modeling was to quantify the decline of the water table that has occurred due to the capping of the Shepley's Hill landfill. The model was run for 100 years using the calibrated aquifer parameters, average recharge (19 inches/year) and the current cap configuration to quantify the decline.

Figure 10 shows the decline of the water table versus time at the location of monitoring well SHL-12. The overburden water table declines about a foot more over the 100 year simulation period, with all of this decline occurring the first five years. Basically, most of the impact of the cap on the water table has probably already occurred, and the impact is somewhat small, less than normal fluctuations of the water table.

Figure 11 shows the water table in the overburden aquifer at the end of 100 years of simulation. It is basically the same configuration as shown in Figure 4, with the exception that a substantial area in the middle of the landfill is unsaturated. In reality, there is probably a thin saturated thickness in much of this area, however, the flow of water through this thin zone of saturation in the overburden is negligible when compared to areas with substantial saturated thickness. Figure 12 shows the potentiometric surface of the bedrock aquifer. It is basically the same as the overburden water table where the overburden water table exists.

Inspection of Figures 6 through 10 indicates that the decline in the water table at the Shepley's Hill landfill has been small, and less than normal fluctuations in response to recharge.

B. No Landfill Cap

To quantify the impact of the landfill cap on the ground water at the Shepley's Hill landfill site, a second run was made assuming the landfill cap did not exist. All other parameters were the same as the base case. Figure 13 shows the water table in the overburden. Figure 14 shows the potentiometric surface of the bedrock aquifer. Differences between these figures and Figures 11 and 12 (the base case) are small. The landfill cap does, however, greatly reduce the flow of ground water into Plow Shop Pond, as the following table indicates.

Table 1
Comparison of Ground Water Flows
With and Without Shepley's Hill Landfill Cap

Flows in cubic feet/day
(+ is groundwater flowing in from boundary)
(- is groundwater flowing out to boundary)

	Overburden		
Boundary	With	Without cap	reduction
northern and Nonacoicus Brook	-11535	-372	-3000.8%
Plow Shop Pond	-1235	-4231	70.8%
Grove Pond	-39091	-41720	6.3%
southern	69983	65532	-6.8%
eastern	-49287	-49907	1.2%

(Table 1 Continued)

	Bedrock Aquifer With	Without cap	reduction
northern and Nonacoicus Brook	18	-372	-3000.8%
Plow Shop Pond	-427	-4231	70.8%
Grove Pond	1649	-41720	6.3%
southern	804	65532	-6.8%
eastern	442	-49907	1.2%

Ground water flow to Plow Shop Pond has been reduced by almost 71 percent. The landfill cap causes ground water flow to the northern boundary to substantially increase. With the landfill cap in place, water runs off the cap and infiltrates at the north side of the landfill. This recharge flows out at the north end of the model towards Nonacoicus Brook. Flow to Grove Pond, and the eastern and southern boundaries of the model are not significantly impacted by the landfill cap as one would expect. Bedrock aquifer flows are generally two orders of magnitude smaller than overburden aquifer flows and are not impacted significantly by the landfill cap.

VII. SENSITIVITY ANALYSIS

A. Enhanced Recharge in Southern Part of Model

During the calibration, it was apparent that modeled heads were somewhat lower than observed around monitoring well SHL-24. One possible reason for this difference is that recharge was too low in this area of the model. As explained in section V.D., recharge was calculated based on the impervious area fraction of the land use. The land use classification around monitoring well SHL-24 was urban open. The actual land use is railroad yard. The original estimate of impervious area fraction was 0.50. During calibration, this was lowered to 0.40. For the actual land use around SHL-24, the impervious area is probably less than ten percent. A new transient calibration simulation was performed using an assumed imperviousness fraction of 0.1 in the southern part of the model.

The recharge input array was modified and the second half of the calibration simulation from 1991 to 1993 was modeled. Figure 15 shows the results of the simulation. Heads increased less than 0.1 foot. The weighted mean differences between observed and modeled head changed from 1.0 feet to 0.82 feet. The model is relatively insensitive to small changes in recharge, thus this change made no significant difference in the calibration.

The reason that modeled heads at SHL-24 did not increase more is the closeness of the monitoring well to Grove Pond. Grove Pond was modeled as a constant head boundary. The hydraulic connection between Grove Pond and overburden aquifer may be much weaker than simulated. Either the hydraulic conductivity is smaller or there may be significant resistance to flow out of Grove Pond.

B. General Head Boundary Sensitivity

Section V.B. discussed the change of the northern boundary from a constant head boundary to a general boundary during the transient calibration. The sensitivity of this change was assessed.

The 18 general head boundary cells were changed to constant head cells and the base scenario, as described in section VI.A., was rerun. Heads changed by less than 0.1 foot across the model. Flows out the northern boundary changed by 0.2 percent after 221 days and by 0.5 percent after 100 years. These changes are less than the numerical precision of the model and are insignificant.

C. Specific Yield

The specific yield of the model was set to an artificially small value, 0.05, during the calibration. A more realistic value for the sandy overburden is about 0.20, although models rarely calibrate with values of this magnitude because of delayed yield. A numerical model and most traditional analytical formulas that predict ground water impact assume instantaneous availability of water from storage. This is a good assumption for a confined aquifer, but water table aquifers have a substantial lag in the drainage of water from the unsaturated zone above the water table (delayed yield).

A sensitivity analysis using a specific yield of 0.20 was conducted by rerunning the base scenario (documented in Section VI.A.). Figure 16 shows the results of this run. It takes slightly longer for the aquifer to reach its steady state position with the larger specific yield. Since alternatives were compared under steady state conditions, the value of the storage coefficient had no impact on these runs and evaluations.

VIII. REFERENCES

ABB Environmental Services, Inc.,"Fort Devens Feasibility Study for Group 1A Sites, Final Remedial Investigation Addendum Report Data Item A009", U.S. Army Environmental Center, December 1993.

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Morrisey,D., Randall,A. and Williams,J., 1988, "Upland Runoff as a Major Source of Recharge to Stratified Drift in the Glaciated Northeast" in Regional aquifer systems of the United States--the northeast glacial aquifers, ed. by Randall and Johnson, Water Resources Association Monograph Series No. 11.

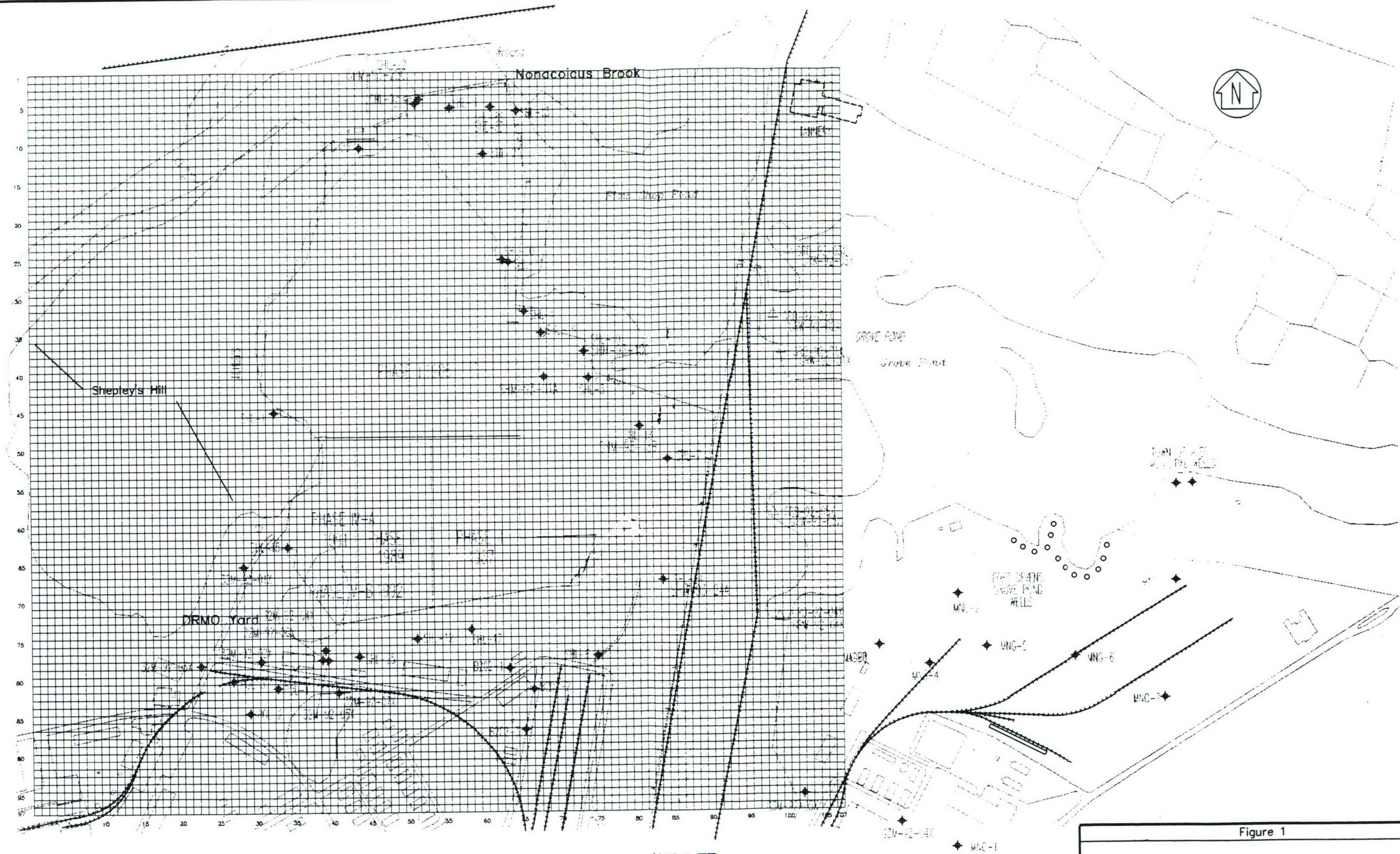

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Figure 1		
Model Grid		
SCALE: 1" = 500'	CONTRACT NO.: 93320.10	DATE: 1-94

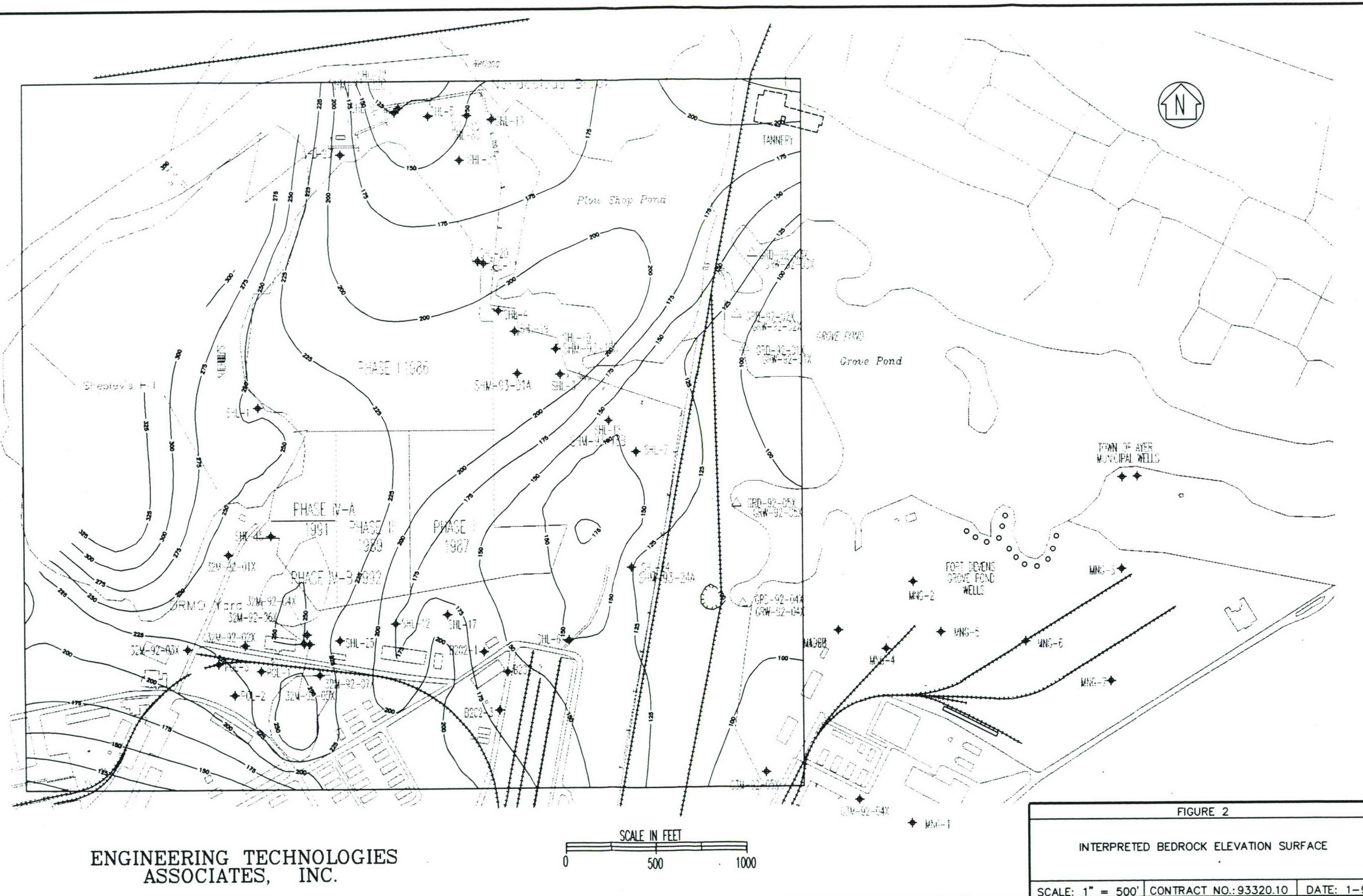

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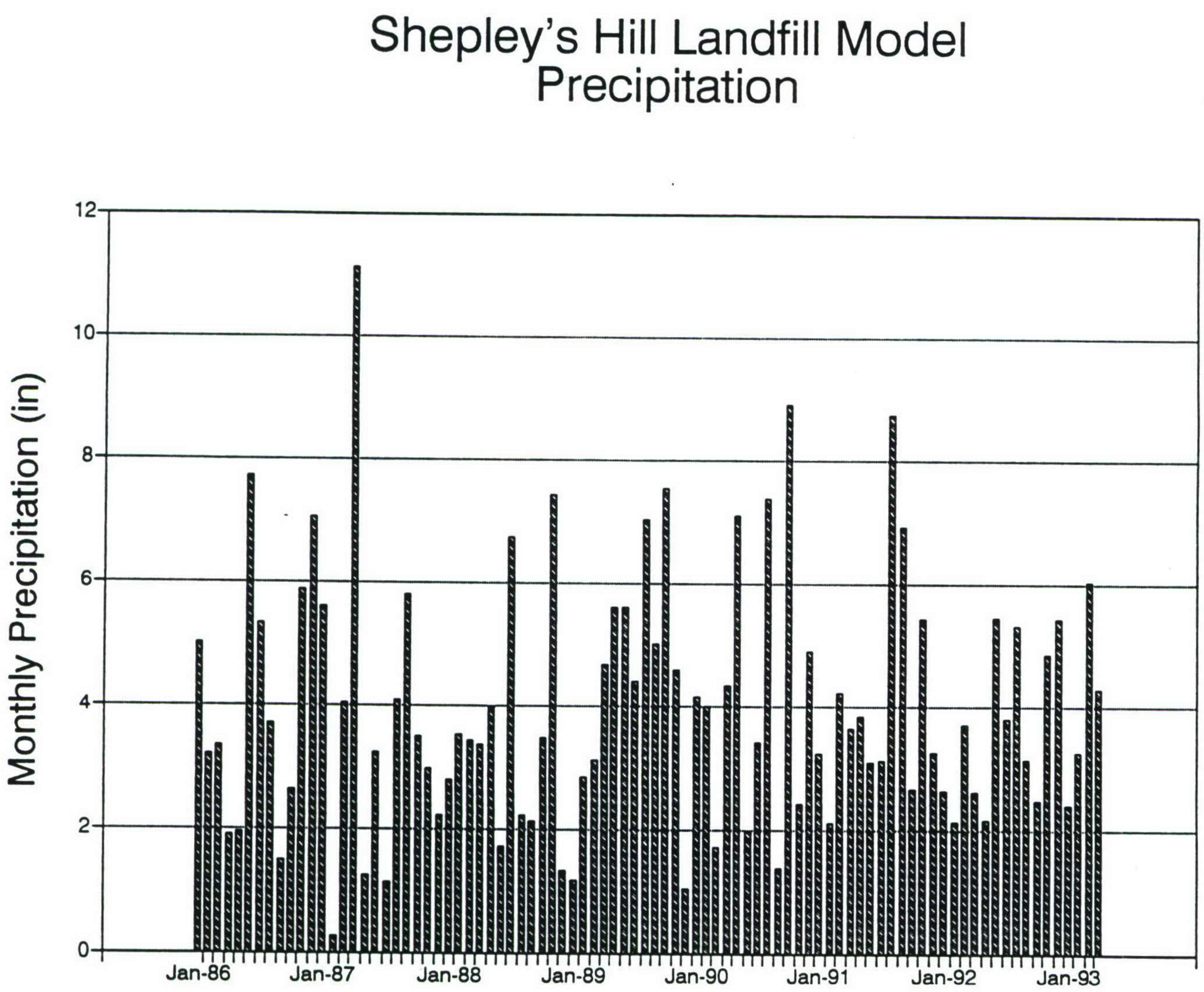
FIGURE 2		
INTERPRETED BEDROCK ELEVATION SURFACE		
SCALE: 1" = 500'	CONTRACT NO.:93320.10	DATE: 1-94

FIGURE 3



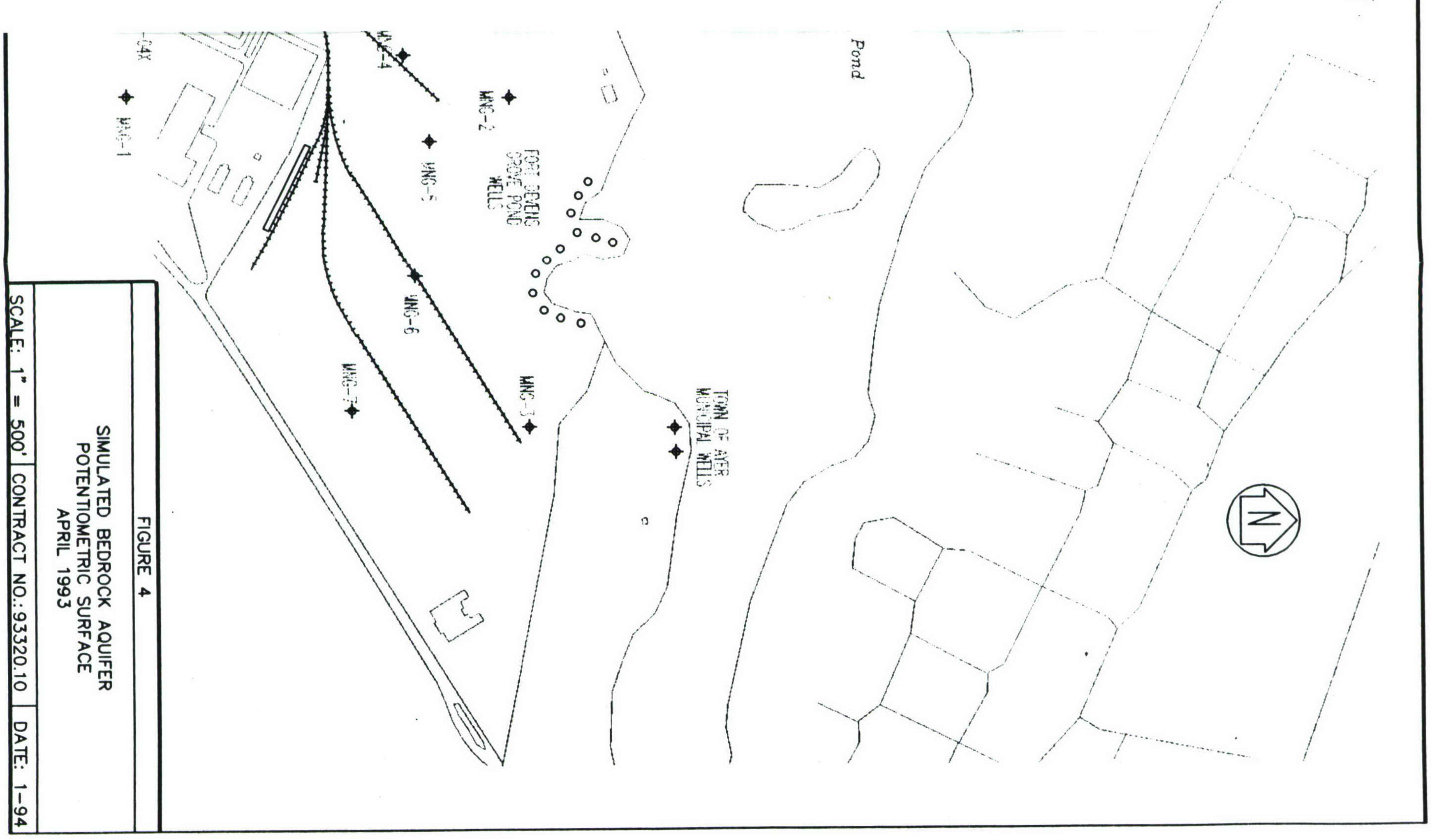
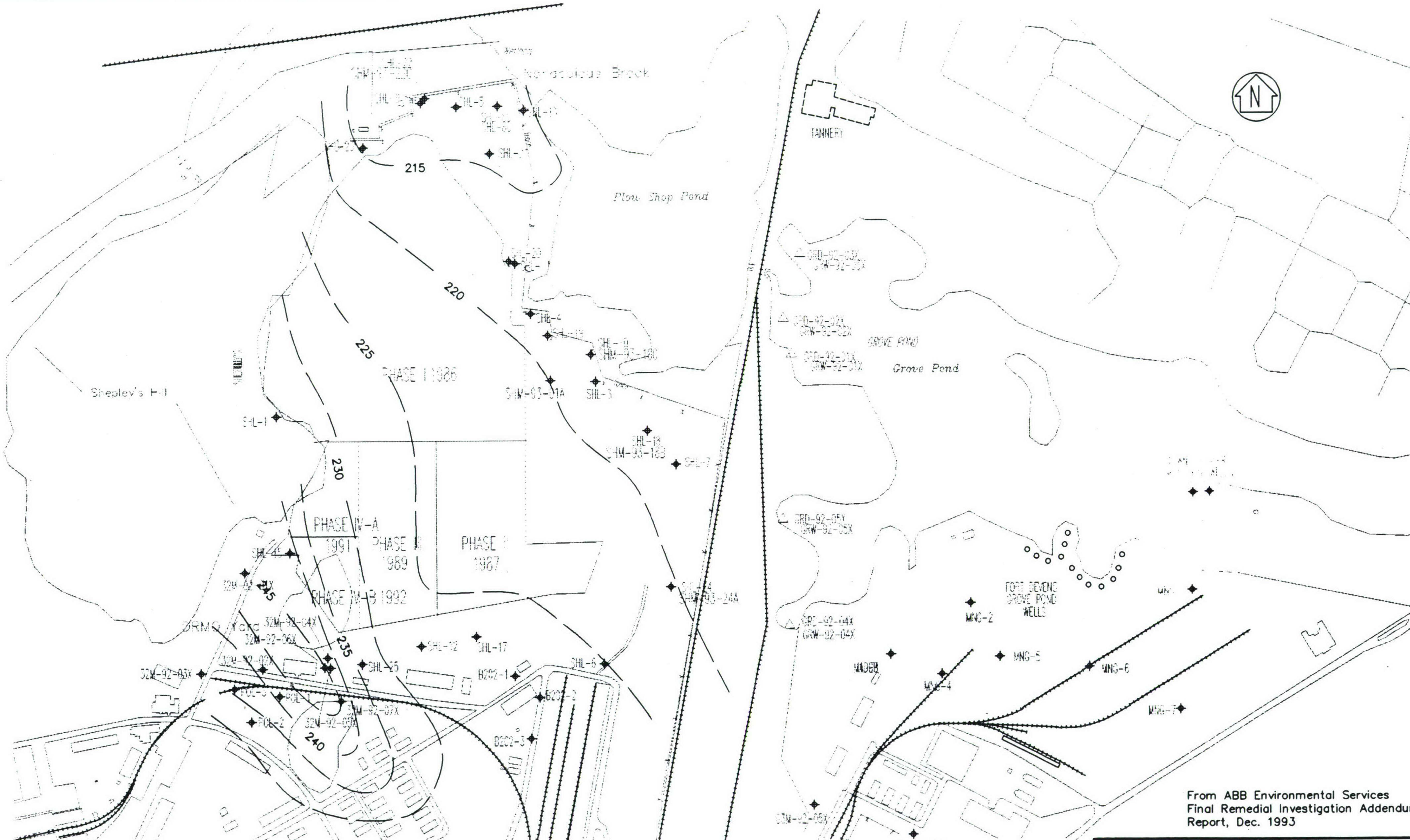


FIGURE 4



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From ABB Environmental Services
Final Remedial Investigation Addendum
Report, Dec. 1993

FIGURE 5

OBSERVED PIEZOMETRIC SURFACE
(JUNE 1993)

SCALE: 1" = 500'	CONTRACT NO.: 93320.10	DATE: 1-94

FIGURE 6

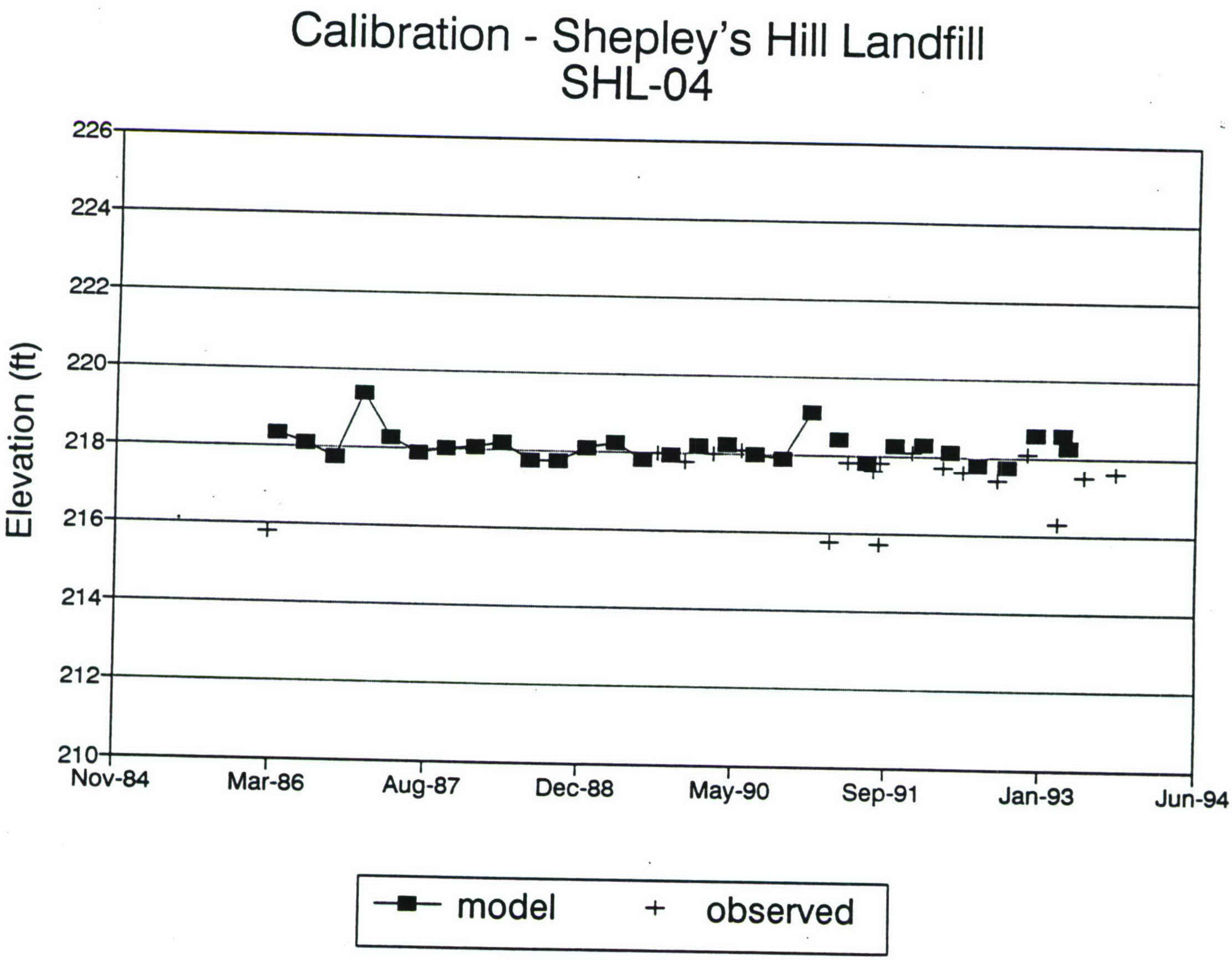

Calibration - Shepley's Hill Landfill
SHL-04
Elevation (ft)
226
224
222
220
218
216
214
212
210
Nov-84
Mar-86
Aug-87
Dec-88
May-90
Sep-91
Jan-93
Jun-94
model
observed

FIGURE 7

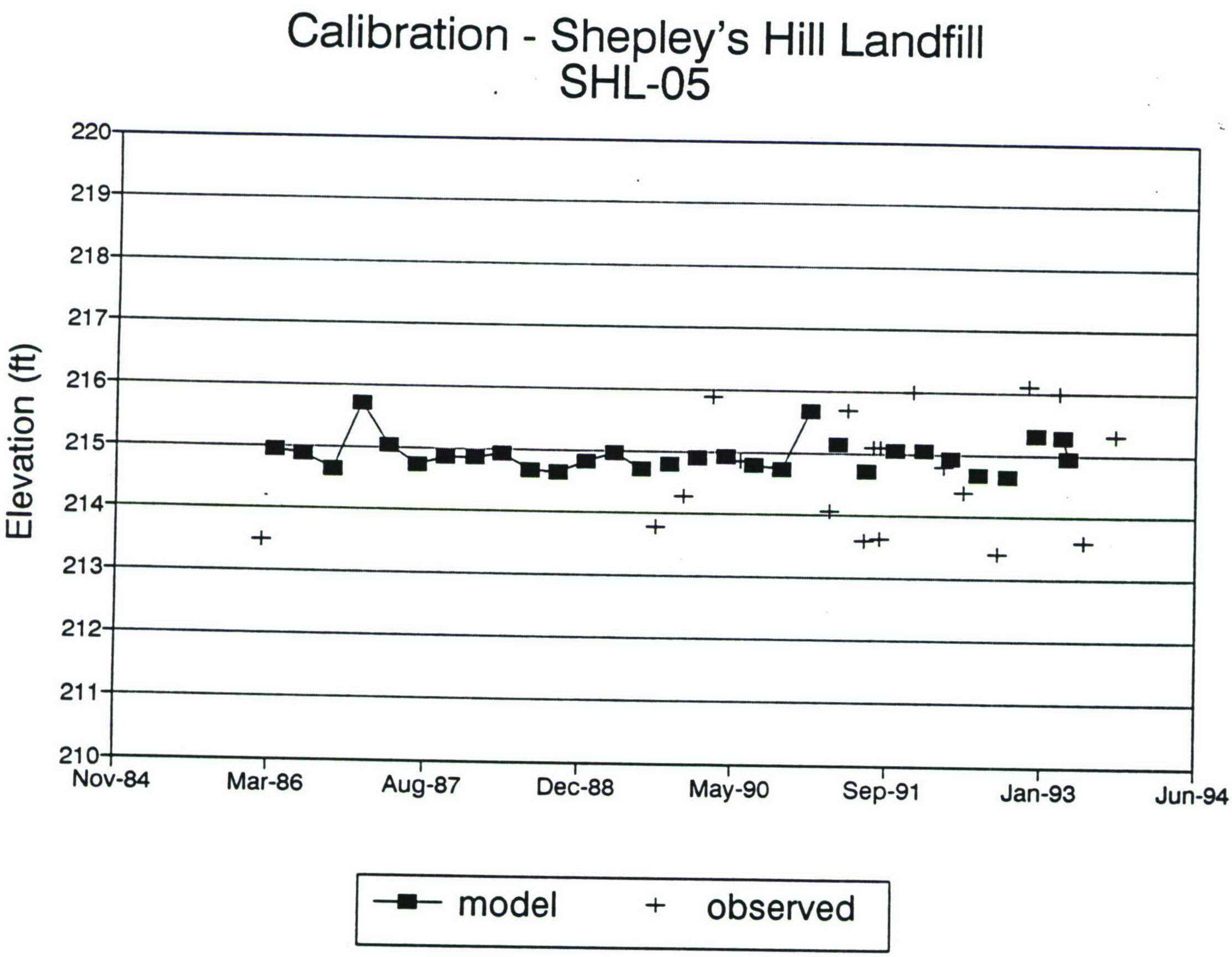
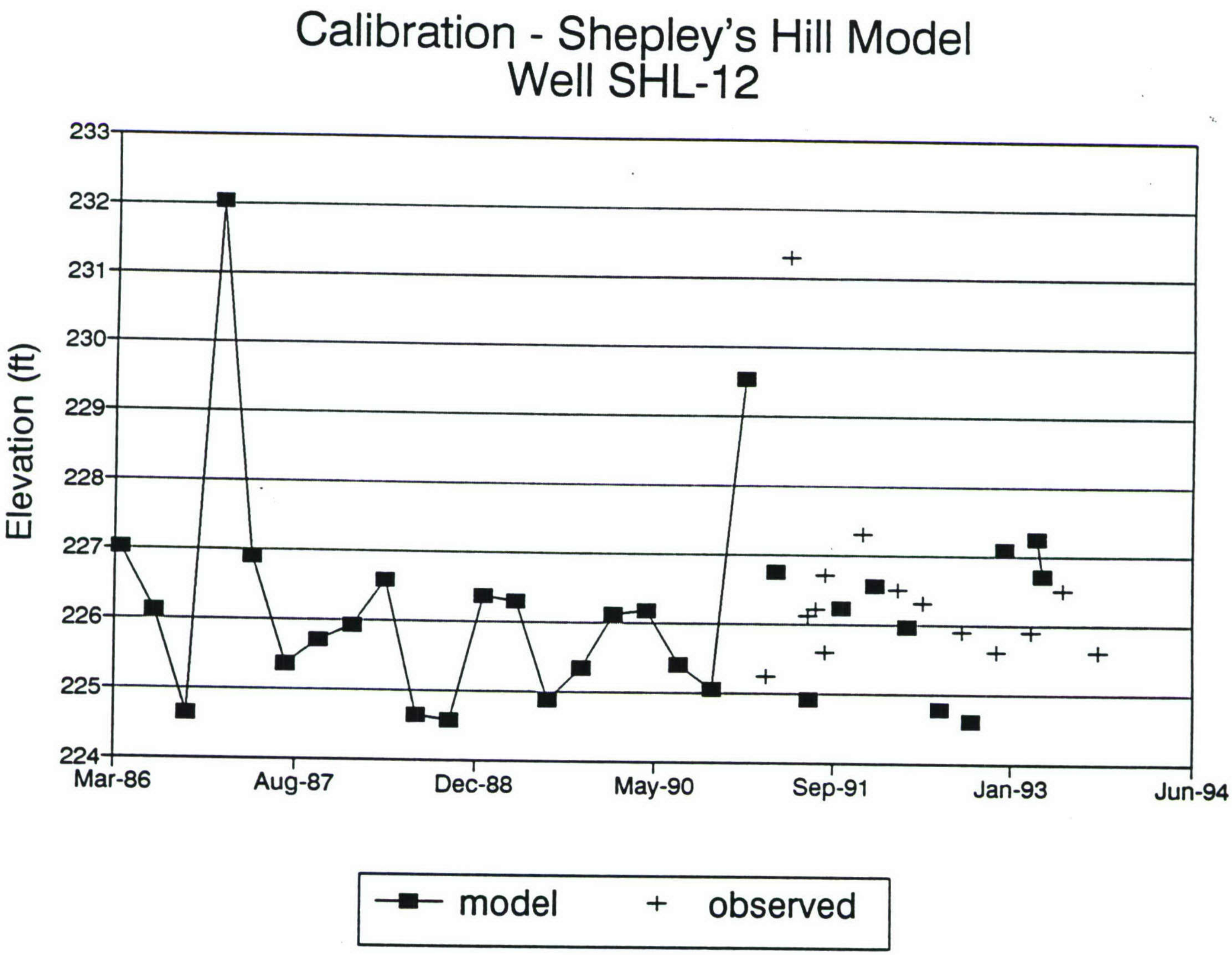

Calibration - Shepley's Hill Landfill
SHL-05
Elevation (ft)
220
219
218
217
216
215
214
213
212
211
210
Nov-84
Mar-86
Aug-87
Dec-88
May-90
Sep-91
Jan-93
Jun-94
model
observed

FIGURE 8



Calibration - Shepley's Hill Model
Well SHL-12
Elevation (ft)
233
232
231
230
229
228
227
226
225
224
Mar-86
Aug-87
Dec-88
May-90
Sep-91
Jan-93
Jun-94
model
observed

FIGURE 9

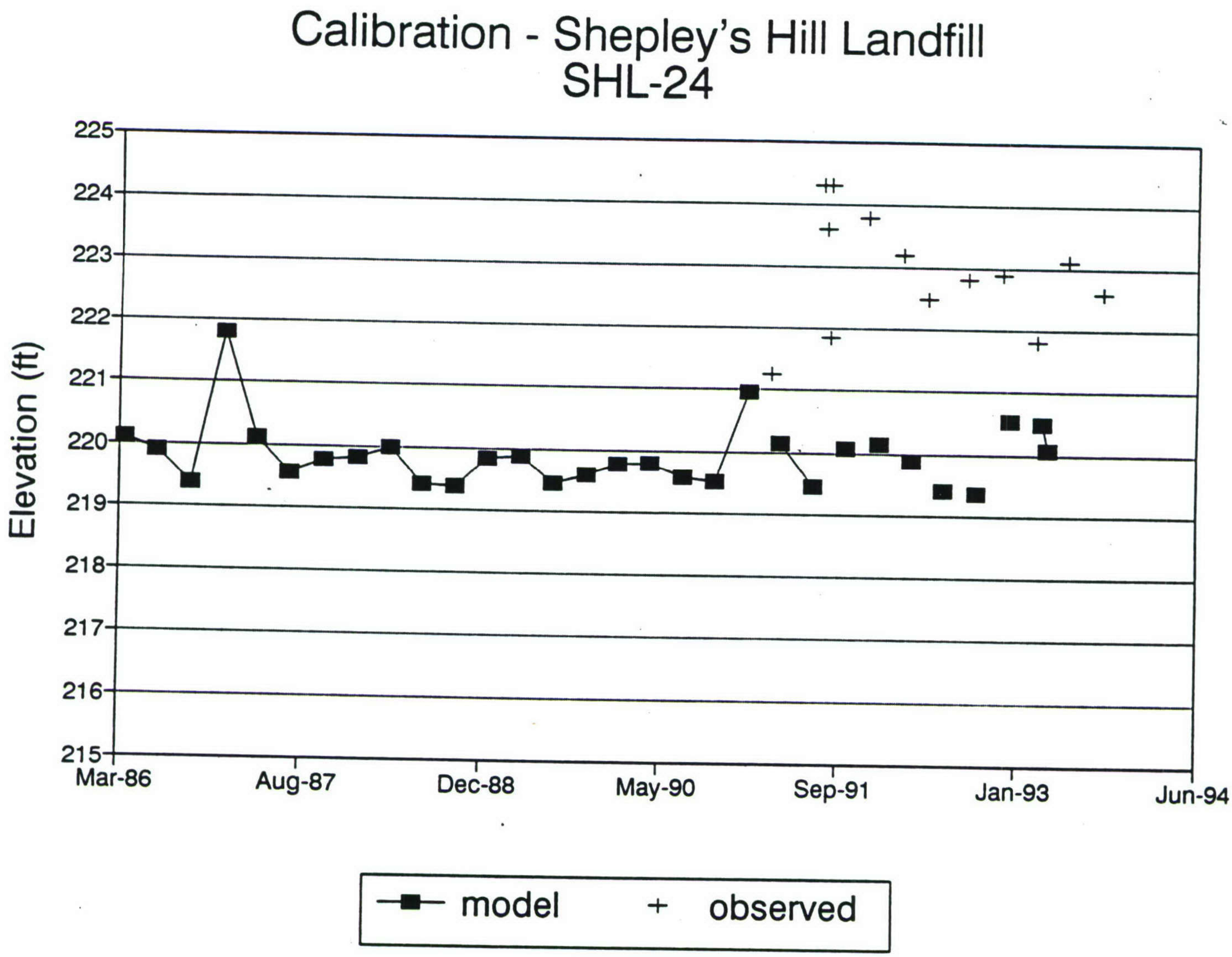

Calibration - Shepley's Hill Landfill
SHL-24
Elevation (ft)
225
224
223
222
221
220
219
218
217
216
215
Mar-86
Aug-87
Dec-88
May-90
Sep-91
Jan-93
Jun-94
model
observed

FIGURE 10

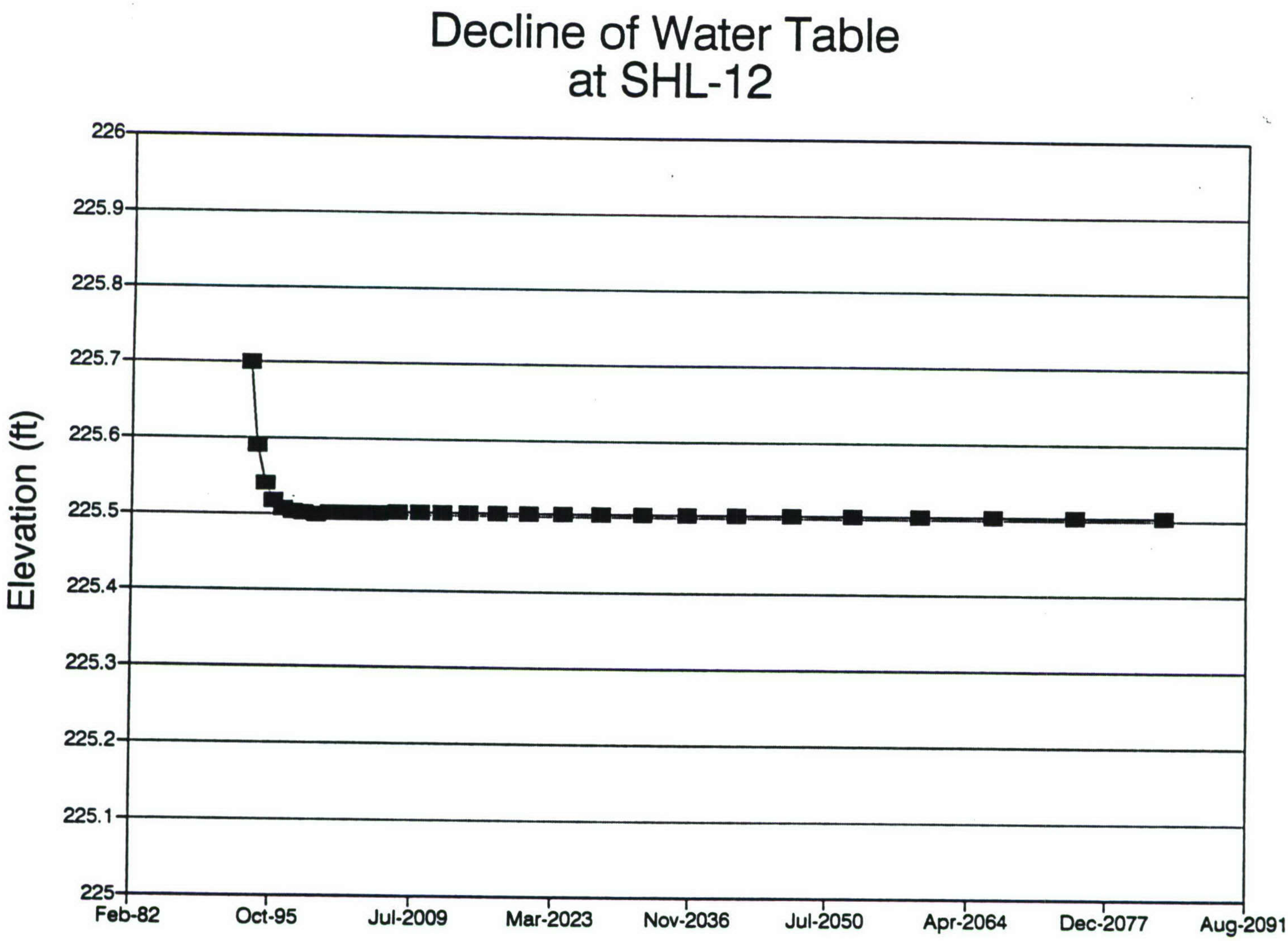

Decline of Water Table
at SHL-12
Elevation (ft)
226
225.9
225.8
225.7
225.6
225.5
225.4
225.3
225.2
225.1
225
Feb-82
Oct-95
Jul-2009
Mar-2023
Nov-2036
Jul-2050
Apr-2064
Dec-2077
Aug-2091

FIGURE 15

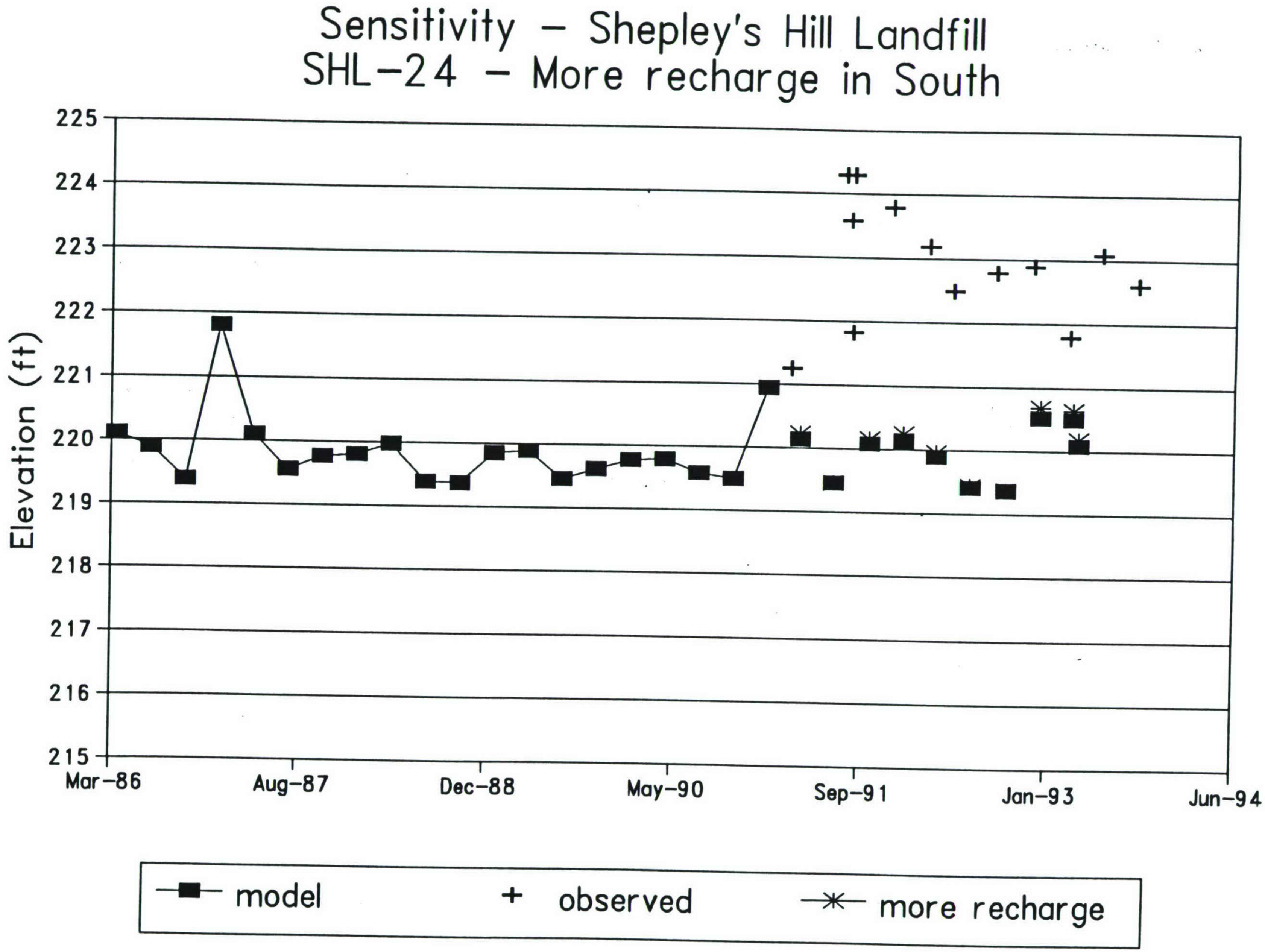
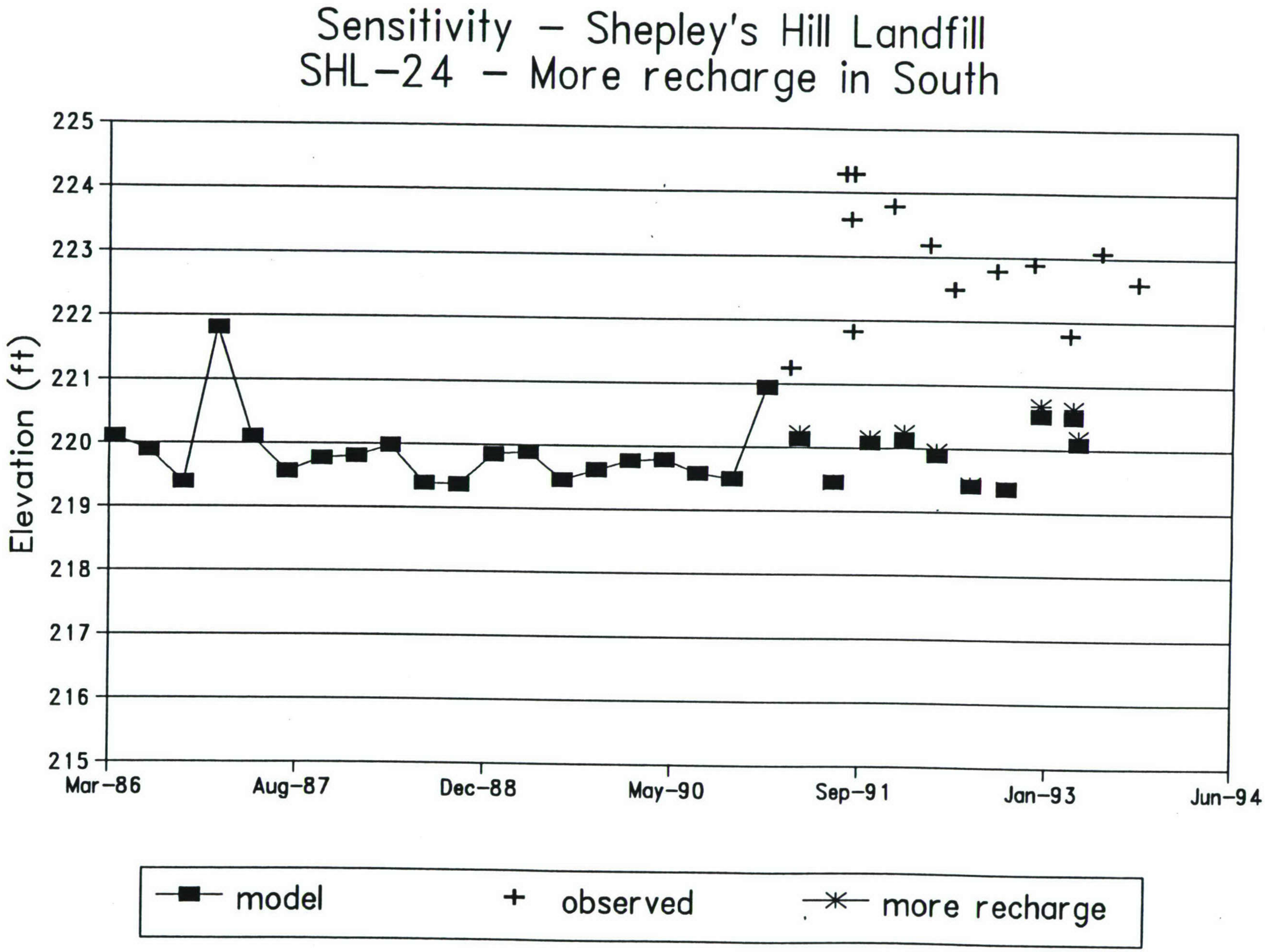
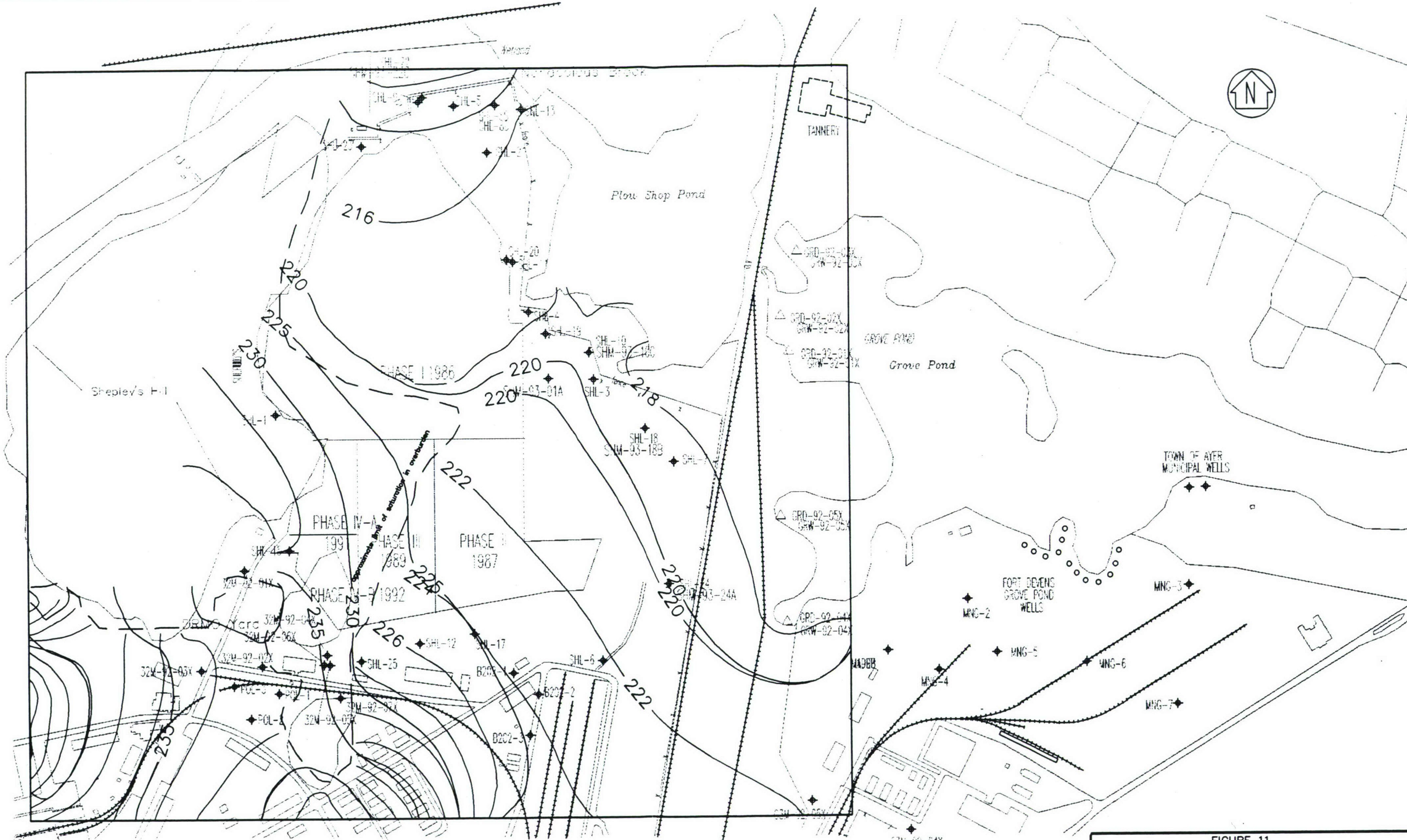

Sensitivity - Shepley's Hill Landfill
SHL-24 - More recharge in South
Elevation (ft)
225
224
223
222
221
220
219
218
217
216
215
Mar-86
Aug-87
Dec-88
May-90
Sep-91
Jan-93
Jun-94
model
observed
more recharge

FIGURE 16



Sensitivity – Shepley's Hill Landfill
SHL-24 – More recharge in South
Elevation (ft)
225
224
223
222
221
220
219
218
217
216
215
Mar-86
Aug-87
Dec-88
May-90
Sep-91
Jan-93
Jun-94
model
observed
more recharge



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SCALE IN FEET

0 500 1000

FIGURE 11

OVERBURDEN AQUIFER
WATER TABLE AFTER
100 YEARS BASE SCENARIO

SCALE: 1" = 500'	CONTRACT NO.: 93320.10	DATE: 1-94

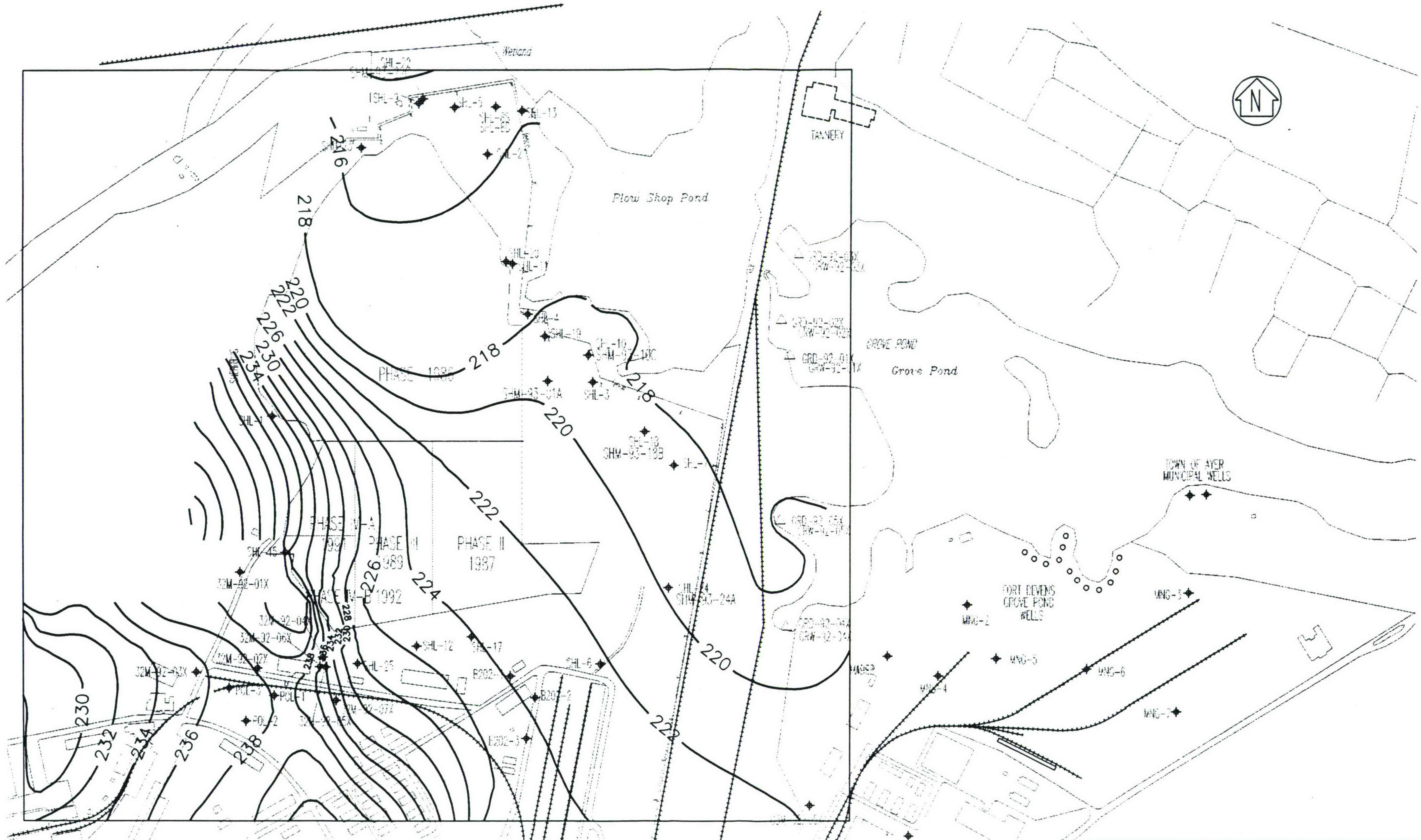

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FIGURE 12		
BEDROCK AQUIFER POTENTIOMETRIC SURFACE AFTER 100 YEARS BASE SCENARIO		
SCALE: 1" = 500'	CONTRACT NO.: 93320.10	DATE: 1-94

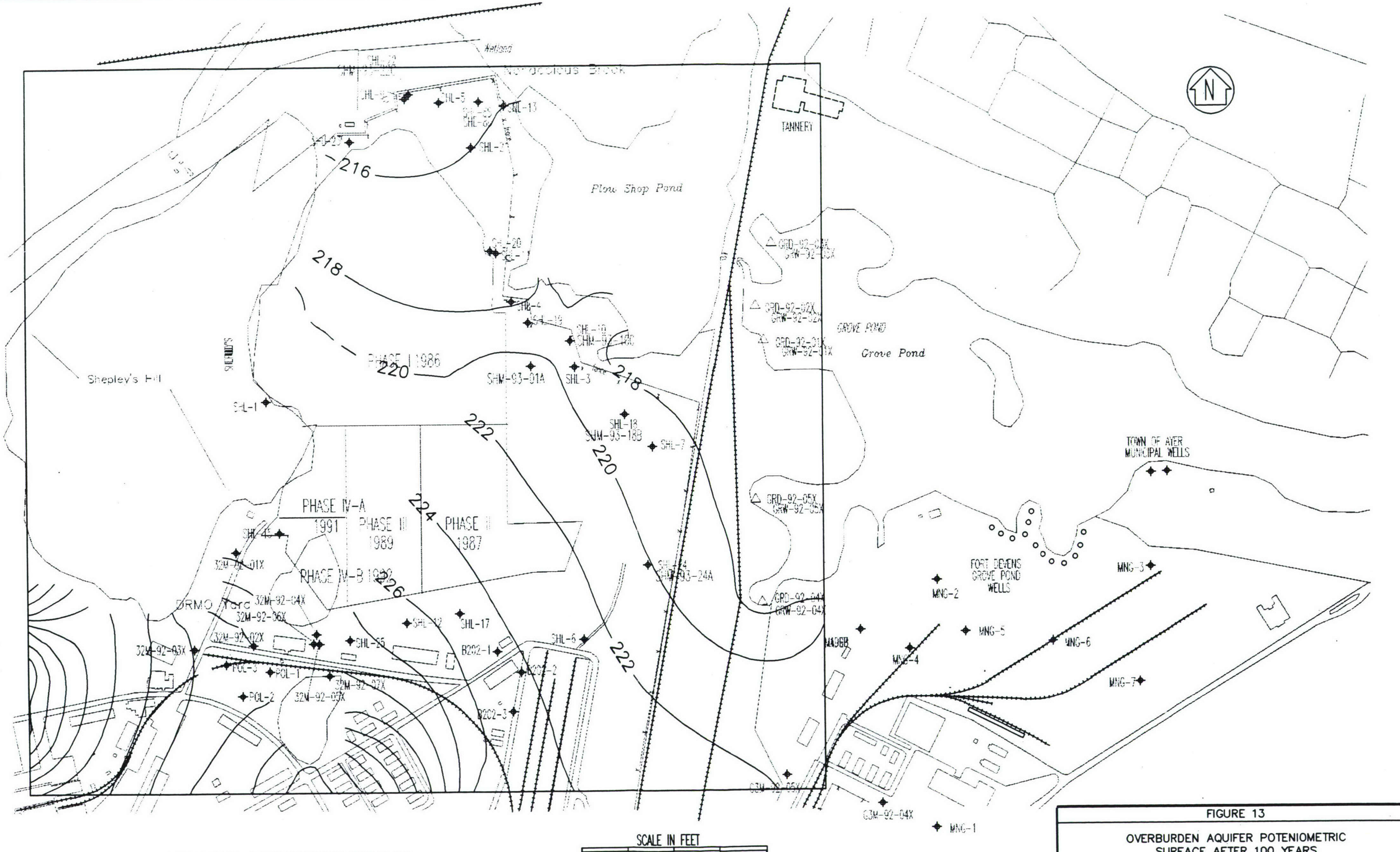

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FIGURE 13

OVERBURDEN AQUIFER POTENIOMETRIC SURFACE AFTER 100 YEARS NO LANDFILL CAP SCENARIO

SCALE: 1" = 500'	CONTRACT NO.:93320.10	DATE: 1-94

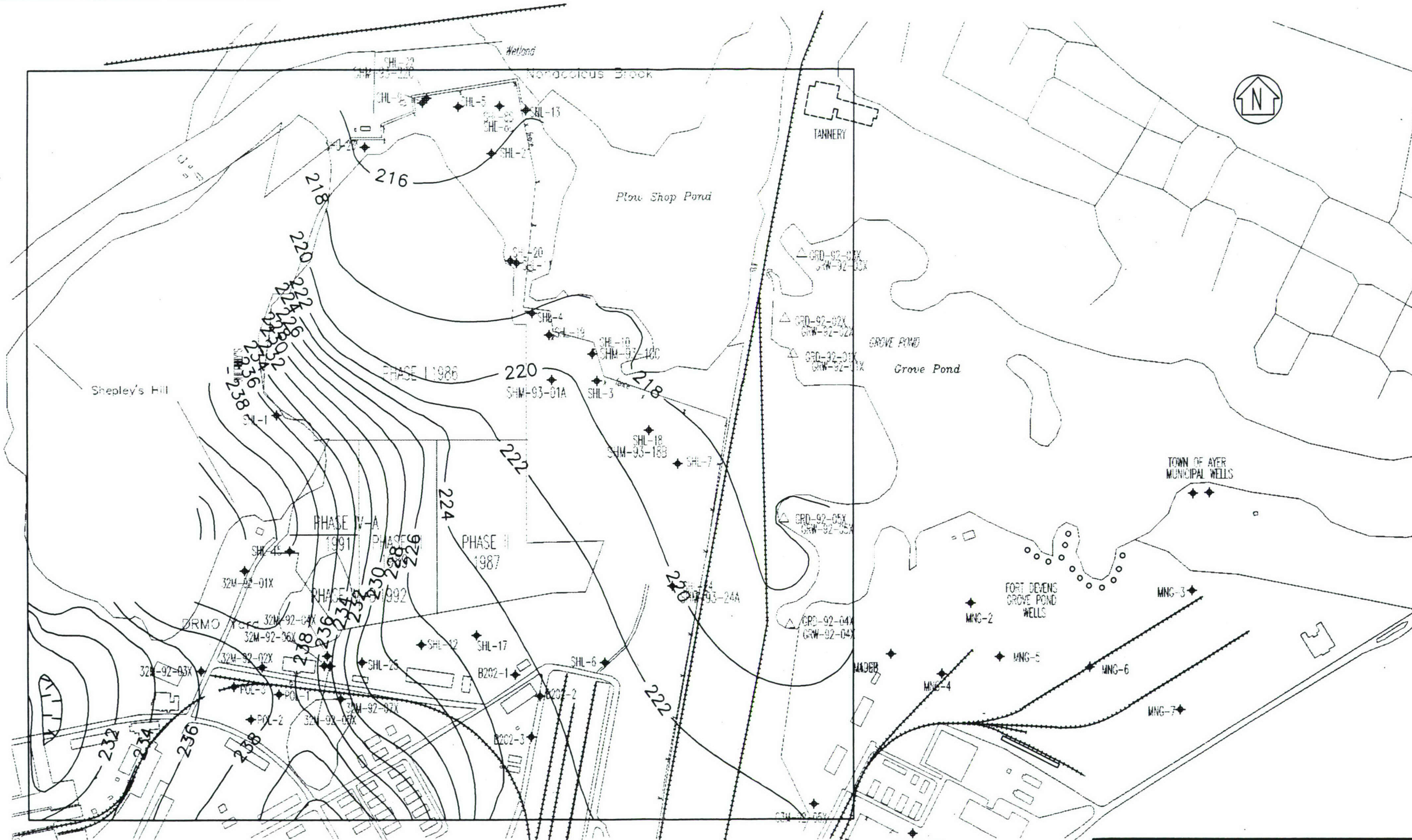

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FIGURE 14

BEDROCK AQUIFER POTENTIOMETRIC
SURFACE AFTER 100 YEARS
NO LANDFILL SCENARIO

SCALE: 1" = 500'	CONTRACT NO.:93320.10	DATE: 1-94

APPENDIX A

MODFLOWP OUTPUT

CALIBRATION FROM 1991 TO 1993

(Not Included In This Report)

APPENDIX B

APPENDIX B

DETAILED COST ASSUMPTIONS AND CALCULATIONS

APPENDIX B

PROJECT:	FEASIBILITY STUDY FOR GROUP 1A SITES ALTERNATIVE SHL-1: NO ACTION	JOB #	7005-12
LOCATION:	SHEPLEY'S HILL LANDFILL OPERABLE UNIT FT. DEVENS, MASSACHUSETTS	DATE	09-Sep-94
ENGINEER:	ABB ENVIRONMENTAL SERVICES, INC.		
ESTIMATOR:	P. R. MARTIN		

ALTERNATIVE SHL-1: NO ACTION
COST SUMMARY TABLE

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
DIRECT COST OF ALTERNATIVE SHL-1: NO ACTION				$0
TOTAL DIRECT COST OF ALTERNATIVE SHL-1: NO ACTION				$0
INDIRECT COST OF ALTERNATIVE SHL-1: NO ACTION				
HEALTH AND SAFETY			5.00%	$0
LEGAL, ADMIN, PERMITTING			5.00%	0
ENGINEERING			10.00%	0
SERVICES DURING CONSTRUCTION			10.00%	0
TOTAL INDIRECT COST OF ALTERNATIVE SHL-1: NO ACTION				$0
TOTAL CAPITAL (DIRECT + INDIRECT) COST				$0
OPERATING AND MAINTENANCE COSTS				
TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS				$0
TOTAL PRESENT WORTH OF ANNUAL O&M COSTS (5% FOR THIRTY YEARS)				$0
TOTAL COST OF ALTERNATIVE SHL-1: NO ACTION				$0

APPENDIX B

PROJECT:	FEASIBILITY STUDY FOR GROUP 1A SITES ALTERNATIVE SHL-2: LIMITED ACTION	JOB #	7005-12
LOCATION:	SHEPLEY'S HILL LANDFILL OPERABLE UNIT FT. DEVENS, MASSACHUSETTS	DATE	09-Sep-94
ENGINEER:	ABB ENVIRONMENTAL SERVICES, INC.		
ESTIMATOR:	P. R. MARTIN		

ALTERNATIVE SHL-2: LIMITED ACTION
COST SUMMARY TABLE

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
DIRECT COST OF ALTERNATIVE SHL-2: LIMITED ACTION				
MOBILIZATION				$90,000
DITCH AND LANDFILL COVER REPAIRS				611,000
INSTITUTIONAL CONTROLS				13,000
TOTAL DIRECT COST OF ALTERNATIVE SHL-2: LIMITED ACTION				$714,000
INDIRECT COST OF ALTERNATIVE SHL-2: LIMITED ACTION				
HEALTH AND SAFETY			5.00%	$36,000
LEGAL, ADMIN, PERMITTING			5.00%	36,000
ENGINEERING			10.00%	71,000
SERVICES DURING CONSTRUCTION			10.00%	71,000
TOTAL INDIRECT COST OF ALTERNATIVE SHL-2: LIMITED ACTION				$214,000
TOTAL CAPITAL (DIRECT + INDIRECT) COST				$928,000
OPERATING AND MAINTENANCE COSTS				
TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS				$84,000
TOTAL PRESENT WORTH OF ANNUAL O&M COSTS (5% FOR THIRTY YEARS)				$1,291,000
TOTAL COST OF ALTERNATIVE SHL-2: LIMITED ACTION				$2,219,000

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES JOB # 7005-12
ALTERNATIVE SHL-2: LIMITED ACTION
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-2: LIMITED ACTION SITE PREPARATION & MOBILIZATION DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SITE PREPARATION				
STAGING AREA				
CLEAR & GRUB LIGHT VEGETATION	0.25	AC	3825.00	$956
GRADE	410	CY	2.00	820
GRAVEL - 12" THICK	1210	SY	3.50	4,235
PARKING AREA - USE EXISTING AREA - OK AS IS				0
DECON AREA - USE EXISTING AREA - OK AS IS				0
SURVEY	1	LS	25000.00	25,000
MOBILIZATION				
EQUIPMENT (IN OR OUT)				
FRONT END LOADER	2	EA	500.00	1,000
DUMP TRUCK	4	EA	250.00	1,000
BACKHOE	2	EA	250.00	500
OFFICE TRAILER	1	MON	150.00	150
STORAGE TRAILER	1	MON	150.00	150
TRAILER DELIVERY, SET-UP, REMOVAL	2	EA	300.00	600
TOILET	4	WK	25.00	100
WATER COOLER	4	WK	25.00	100
WATER	20	DAY	15.00	300
TELEPHONE SERVICE	1	MON	500.00	500
ELECTRICITY	1	MON	250.00	250
PICK-UP	1	MON	1000.00	1,000
OFFICE EQUIPMENT	1	MON	1000.00	1,000
PUMPS, TOOLS, MINOR EQUIPMENT	1	LS	2500.00	2,500
LABORER (1 MAN*5 DAY/MAN*8 HR/DAY)	40	MNHR	30.00	1,200
CARPENTER (1 MAN*5 DAY/MAN*8 HR/DAY)	40	MNHR	38.00	1,520
ELECTRICIAN (1 MAN*5 DAY/MAN*8 HR/DAY)	40	MNHR	41.50	1,660
SITE SUPERINTENDANT (1 MON*210HR/MON)	210	MNHR	60.00	12,600
FOREMAN (1 MON*210HR/MON)	210	MNHR	50.00	10,500
CLERK/TYPIST (1 MON*168HR/MON)	168	MNHR	25.00	4,200
UNDEVELOPED DESIGN DETAILS ~25%				18,159
TOTAL MOBILIZATION				$90,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-2: LIMITED ACTION
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-2: LIMITED ACTION
DITCH & LANDFILL COVER REPAIRS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
DITCH REPAIR				
CLEAN DITCH – BACKHOE & OPERATOR	2	DAY	1300.00	$2,600
LABORER – 2 EA	32	MNHR	30.00	960
DUMP TRUCK & DRIVER	2	DAY	665.00	1,330
RIPRAP – 1' THICKx15'Wx500'L	300	CY	30.00	9,000
LANDFILL COVER REPAIRS				
FILL & PATCH "POND" IN COVER				
BACKHOE & OPERATOR	5	DAY	1300.00	6,500
LABORER – 4 EA, 2 WKS/EA	320	MNHR	30.00	9,600
FILL MATERIAL	300	CY	20.00	6,000
GEOMEMBRANE	60000	SF	0.35	21,000
VIBRATORY PLATE COMPACTOR	5	DAY	60.00	300
10-3 DRAINAGE SAND	1100	CY	8.00	8,800
FILTER FABRIC	60000	SF	0.16	9,600
1' VEGETATIVE COVER	1200	CY	7.50	9,000
SEED, FERTILIZE, MULCH	2	AC	2000.00	4,000
SPREAD & COMPACT, EQUIP & OPER	5	DAY	1450.00	7,250
EVALUATION/IMPROVEMENT OF STORMWATER DIVERSION AND DRAINAGE				
EVALUATION OF LANDFILL CAP RUNOFF PATTERNS, DITCH CAPACITIES, STORMWATER DRAINAGE SYSTEMS UPGRADIENT OF LANDFILL AND, RUN-UNDER ALONG WESTERN EDGE OF LANDFILL	1	LS	43000.00	43,000
REPLACE/INSTALL STORM SEWERS/DRAINS				
18" DIA RCP	800	LF	45.00	36,000
24" DIA RCP	800	LF	55.00	44,000
36" DIA RCP	1600	LF	100.00	160,000
REDUCE RUN-UNDER ALONG WESTERN EDGE	1	LS	90000.00	90,000
MONITORING WELL DRILLING	3	EA	6600.00	19,800
UNDEVELOPED DESIGN DETAILS ~25%				122,260
TOTAL DITCH & LANDFILL COVER REPAIRS				$611,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES
ALTERNATIVE SHL-2: LIMITED ACTION
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

JOB # 7005-12
DATE 09-Sep-94

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-2: LIMITED ACTION INSTITUTIONAL CONTROLS DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
INSTITUTIONAL CONTROLS	1	LS	10000.00	$10,000
UNDEVELOPED DESIGN DETAILS ~25%				3,000
TOTAL INSTITUTIONAL CONTROLS				$13,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-2: LIMITED ACTION
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-2: LIMITED ACTION
ANNUAL O&M COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
LANDFILL COVER MAINTENANCE				
GENERAL REPAIR				
DUMP TRUCK & DRIVER	1	DAY	665.00	$665
FRONT END LOADER & OPERATOR	1	DAY	800.00	800
LABORER – 2 EA	16	MNHR	30.00	480
MATERIALS	1	LS	500.00	500
INSPECTION – 2 DAY @ 2 MEN/DAY	32	MNHR	75.00	2,400
MOWING – TRACTOR AND OPERATOR	4	DAY	500.00	2,000
GROUNDWATER MONITORING 14 WELLS, SEMI-ANNUALLY	2	EVENT	8560.00	17,120
GROUNDWATER SAMPLE ANALYSIS 14 SAMPLES PLUS 3 QA/QC EQUIVALENT SEMI-ANNUALLY, VOCs, INORGANICS, WATER QUALITY PARAMETERS	34	SMPL	785.00	26,690
LANDFILL GAS MONITORING 18 POINTS, QUARTERLY AND ANALYSIS	4	EVENT	3000.00	12,000
LANDFILL GAS COLLECTION SYSTEM MAINTENANCE				
LABORER	8	MNHR	30.00	240
MATERIALS	1	LS	250.00	250
TWO YEAR REPORT TO DEP – ANNUALIZED	0.4878	LS	1000.00	488
FIVE YEAR EDUCATIONAL PROGRAM PUBLIC MEETING – ANNUALIZED	0.1810	LS	5000.00	905
FIVE YEAR SITE REVIEW – ANNUALIZED	0.1810	LS	15000.00	2,715
UNDEVELOPED DESIGN DETAILS ~25%				16,748
TOTAL ANNUAL O&M COSTS				$84,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
COST SUMMARY TABLE

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
DIRECT COST OF ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE				
HYDROGEOLOGICAL STUDY				$126,000
TREATABILITY/PILOT TESTING				65,000
SITE PREPARATION AND MOBILIZATION				283,000
DITCH AND LANDFILL COVER REPAIRS				611,000
EXTRACTION SYSTEM/DISCHARGE PIPE CONSTRUCTION				152,000
TREATMENT FACILITY CONSTRUCTION				733,000
INSTITUTIONAL CONTROLS				13,000
TOTAL DIRECT COST OF ALTERNATIVE SHL-5: COLLECTION/ ION EXCHANGE TREATMENT/DISCHARGE				$1,983,000
INDIRECT COST OF ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE				
HEALTH AND SAFETY			5.00%	$99,000
LEGAL, ADMIN, PERMITTING			5.00%	99,000
ENGINEERING			10.00%	198,000
SERVICES DURING CONSTRUCTION			10.00%	198,000
TOTAL INDIRECT COST OF ALTERNATIVE SHL-5: COLLECTION/ ION EXCHANGE TREATMENT/DISCHARGE				$594,000
TOTAL CAPITAL (DIRECT + INDIRECT) COST				$2,577,000
OPERATING AND MAINTENANCE COSTS				
TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS				$426,000
TOTAL PRESENT WORTH OF ANNUAL O&M COSTS (5% FOR THIRTY YEARS)				$6,549,000
TOTAL COST OF ALTERNATIVE SHL-5: COLLECTION/ ION EXCHANGE TREATMENT/DISCHARGE				$9,126,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
HYDROGEOLOGICAL STUDY				
MODELING, PERMEABILITY TESTS, WATER LEVELS, WELL INSTALLATION LABOR	1	LS	57000.00	$57,000
PIEZOMETER INSTALLATION 1 SINGLE 4 NESTED PAIRS 2 NESTED TRIPLETS	1	LS	44000.00	44,000
UNDEVELOPED DESIGN DETAILS ~25%				25,000
TOTAL HYDROGEOLOGICAL STUDY				$126,000
TREATABILITY/PILOT TESTING	1	LS	52000.00	$52,000
UNDEVELOPED DESIGN DETAILS ~25%				13,000
TOTAL TREATABILITY/PILOT TESTING				$65,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
SITE PREPARATION AND MOBILIZATION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SURVEY	1	LS	25000.00	$25,000
SITE PREPARATION				
STAGING AREA				
CLEAR & GRUB LIGHT VEGETATION	1	AC	3825.00	3,825
GRADE	1640	CY	2.00	3,280
GRAVEL - 12" THICK	4840	SY	3.50	16,940
PARKING AREA				
USE EXISTING AREA - OK AS IS				
DECON AREA				
USE EXISTING AREA - OK AS IS				0
SUBTOTAL SITE PREPARATION				$24,045

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
SITE PREPARATION AND MOBILIZATION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SITE PREPARATION - TOTAL PAGE SHL5-3				$24,045
MOBILIZATION				
EQUIPMENT (IN OR OUT)				
FRONT END LOADER	2	EA	500.00	1,000
DUMP TRUCK	2	EA	250.00	500
BACKHOE	2	EA	250.00	500
OFFICE TRAILER	6	MON	150.00	900
STORAGE TRAILER	6	MON	150.00	900
TRAILER DELIVERY, SET-UP, REMOVAL	2	EA	300.00	600
TOILET - 2 EA	52	WK	25.00	1,300
WATER COOLER - 2 EA	52	WK	25.00	1,300
WATER	260	DAY	15.00	3,900
TELEPHONE SERVICE	6	MON	500.00	3,000
ELECTRICITY	6	MON	250.00	1,500
PICK-UP	6	MON	1000.00	6,000
OFFICE EQUIPMENT	6	MON	1000.00	6,000
PUMPS, TOOLS, MINOR EQUIPMENT	1	LS	2500.00	2,500
LABORER (2 MEN*5 DAY/MAN*8 HR/DAY)	80	MNHR	30.00	2,400
CARPENTER (2 MEN*5 DAY/MAN*8 HR/DAY)	80	MNHR	38.00	3,040
ELECTRICIAN (2 MEN*5 DAY/MAN*8 HR/DAY)	80	MNHR	41.50	3,320
SITE SUPERINTENDANT (6 MON*210HR/MON)	1260	MNHR	60.00	75,600
FOREMAN (6 MON*210HR/MON)	1260	MNHR	50.00	63,000
CLERK/TYPIST (6 MON*168HR/MON)	1008	MNHR	25.00	25,200
UNDEVELOPED DESIGN DETAILS ~25%				56,495
TOTAL SITE PREPARATION AND MOBILIZATION				$283,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
DITCH & LANDFILL COVER REPAIRS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
DITCH REPAIR				
CLEAN DITCH – BACKHOE & OPERATOR	2	DAY	1300.00	$2,600
LABORER – 2 EA	32	MNHR	30.00	960
DUMP TRUCK & DRIVER	2	DAY	665.00	1,330
RIPRAP – 1' THICKx15'Wx500'L	300	CY	30.00	9,000
LANDFILL COVER REPAIRS				
FILL & PATCH "POND" IN COVER				
BACKHOE & OPERATOR	5	DAY	1300.00	6,500
LABORER – 4 EA, 2 WKS/EA	320	MNHR	30.00	9,600
FILL MATERIAL	300	CY	20.00	6,000
GEOMEMBRANE	60000	SF	0.35	21,000
VIBRATORY PLATE COMPACTOR	5	DAY	60.00	300
10-3 DRAINAGE SAND	1100	CY	8.00	8,800
FILTER FABRIC	60000	SF	0.16	9,600
1' VEGETATIVE COVER	1200	CY	7.50	9,000
SEED, FERTILIZE, MULCH	2	AC	2000.00	4,000
SPREAD & COMPACT, EQUIP & OPER	5	DAY	1450.00	7,250
EVALUATION/IMPROVEMENT OF STORMWATER DIVERSION AND DRAINAGE				
EVALUATION OF LANDFILL CAP RUNOFF PATTERNS, DITCH CAPACITIES, STORMWATER DRAINAGE SYSTEMS UPGRADIENT OF LANDFILL AND, RUN-UNDER ALONG WESTERN EDGE OF LANDFILL	1	LS	43000.00	43,000
REPLACE/INSTALL STORM SEWERS/DRAINS				
18" DIA RCP	800	LF	45.00	36,000
24" DIA RCP	800	LF	55.00	44,000
36" DIA RCP	1600	LF	100.00	160,000
REDUCE RUN-UNDER ALONG WESTERN EDGE	1	LS	90000.00	90,000
MONITORING WELL DRILLING	3	EA	6600.00	19,800
UNDEVELOPED DESIGN DETAILS ~25%				122,260
TOTAL DITCH & LANDFILL COVER REPAIRS				$611,000

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
EXTRACTION SYSTEM/DISCHARGE PIPE CONSTRUCTION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
EXTRACTION SYSTEM CONSTRUCTION				
6" EXTRACTION WELL	1	EA	6700.00	$6,700
5 HP PUMP & CONTROLS	1	EA	4000.00	4,000
4"/2" PE CONTAINMENT/FORCE MAIN	2500	LF	20.00	50,000
AIR RELEASE MANHOLE	2	EA	3500.00	7,000
DISCHARGE PIPE CONSTRUCTION				
4" DIA PE GRAVITY DISCHARGE PIPE	3000	LF	15.00	45,000
MANHOLE	6	EA	2500.00	15,000
RIPRAP AT OUTLET	10	CY	30.00	300
UNDEVELOPED DESIGN DETAILS ~25%				30,700
TOTAL EXTRACTION SYSTEM/DISCHARGE PIPE CONSTRUCTION				$152,000

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
TREATMENT FACILITY CONSTRUCTION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
PRE-ENGINEERED STRUCTURE ON CONCRETE SLAB (28'x44'x15'H)	1232	SF	65.00	$80,080
BUILDING HVAC & PLUMBING	1232	SF	40.00	49,280
BUILDING ELECTRICAL	1232	SF	40.00	49,280
CONCRETE CHEMICAL CONTAINMENT BERM	40	LF	10.00	400
INTERIOR PARTITION (ELEC ROOM/OFFICE)	200	SF	8.00	1,600
OFFICE CEILING	150	SF	5.00	750
OFFICE DOOR	1	EA	750.00	750
OFFICE WINDOW	1	EA	400.00	400
SEPTIC SYSTEM	1	LS	5000.00	5,000
ELECTRICAL SERVICE	1600	LF	20.00	32,000
POTABLE WATER LINE	1200	LF	25.00	30,000
FIRE HYDRANT	1	EA	1000.00	1,000
SUBTOTAL TREATMENT FACILITY				$250,540

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
TREATMENT FACILITY CONSTRUCTION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
TOTAL PAGE SHL 5-7				$250,540
TREATMENT SYSTEM				
FEED PUMPS AND 10,000 GAL EQUALIZATION TANK	1	LS	20000.00	20,000
SAND FILTRATION EQUIPMENT	1	LS	7950.00	7,950
CARBON FILTRATION EQUIPMENT	1	LS	6125.00	6,125
BACKWASH SOLIDS REMOVAL EQUIPMENT	1	LS	12580.00	12,580
FILTER PRESS	1	LS	16600.00	16,600
ION EXCHANGE EQUIPMENT	1	LS	75000.00	75,000
EVAPORATION EQUIPMENT	1	LS	65000.00	65,000
INSTALLATION	1	LS	40000.00	40,000
START-UP & TRAINING	1	LS	18500.00	18,500
START-UP MONITORING & ANALYSIS	1	LS	10000.00	10,000
AIR COMPRESSOR	1	LS	10000.00	10,000
PROCESS PIPING - 4" SCH 80 PVC (PIPE, FITTINGS, SUPPORTS, VALVES, ETC.)	250	LF	40.00	10,000
PROCESS POWER CIRCUITS	500	LF	10.00	5,000
INSTRUMENTATION NOT SUPPLIED WITH EQUIPMENT	10	EA	1000.00	10,000
INSTRUMENTATION CIRCUITS	500	LF	8.00	4,000
CONTROL PANEL/MCC	1	LS	25000.00	25,000
UNDEVELOPED DESIGN DETAILS ~25%				146,705
TOTAL TREATMENT FACILITY CONSTRUCTION				$733,000

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005–12
ALTERNATIVE SHL–5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09–Sep–94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL–5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
INSTITUTIONAL CONTROLS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
INSTITUTIONAL CONTROLS	1	LS	10000.00	$10,000
UNDEVELOPED DESIGN DETAILS ~25%				3,000
TOTAL INSTITUTIONAL CONTROLS				$13,000

PROJECT:	FEASIBILITY STUDY FOR GROUP 1A SITES ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE	JOB #	7005-12
LOCATION:	SHEPLEY'S HILL LANDFILL OPERABLE UNIT FT. DEVENS, MASSACHUSETTS	DATE	09-Sep-94
ENGINEER:	ABB ENVIRONMENTAL SERVICES, INC.		
ESTIMATOR:	P. R. MARTIN		

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE

ANNUAL O&M COSTS DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
LANDFILL COVER GENERAL REPAIR				
GENERAL MAINTENANCE				
DUMP TRUCK & DRIVER	1	DAY	665.00	$665
FRONT END LOADER & OPERATOR	1	DAY	800.00	800
LABORER - 2 EA	16	MNHR	30.00	480
MATERIALS	1	LS	500.00	500
MOWING - TRACTOR & OPERATOR	4	DAY	500.00	2,000
INSPECTION - 2 DAY @ 2 MEN/DAY	32	MNHR	75.00	2,400
INFLUENT & EFFLUENT GROUNDWATER WEEKLY MONITORING				
VOCs	104	SMPL	300.00	31,200
INORGANICS - METALS	104	SMPL	270.00	28,080
INORGANICS - WATER QUAL PARAMETERS	24	SMPL	215.00	5,160
GROUNDWATER MONITORING				
14 WELLS, SEMI-ANNUALLY	2	EVENT	8560.00	17,120
GROUNDWATER SAMPLE ANALYSIS	34	SMPL	785.00	26,690
14 SAMPLES PLUS 3 SAMPLE QA/QC EQUIVALENT				
SEMI-ANNUALLY, VOCs, INORGANICS, WATER QUALITY PARAMETERS				
LANDFILL GAS MONITORING				
18 POINTS, QUARTERLY AND ANALYSIS	4	EVENT	3000.00	12,000
			TOTAL THIS PAGE	$127,095

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES JOB # 7005-12
ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-5: COLLECTION/ION EXCHANGE TREATMENT/DISCHARGE

ANNUAL O&M COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
TOTAL PREVIOUS PAGE				$127,095
TREATMENT FACILITY OPERATION				
FILTER PUMP	15768	MGAL	0.70	11,038
CARBON REPLACEMENT	15768	MGAL	0.15	2,365
SLUDGE DISPOSAL	15768	MGAL	0.15	2,365
IX ACID	15768	MGAL	0.25	3,942
IX CAUSTIC	15768	MGAL	0.40	6,307
IX EVAPORATOR	15768	MGAL	3.10	48,881
IX WASTE	15768	MGAL	2.79	43,993
IX PUMP	15768	MGAL	0.02	315
OPERATOR	2080	MNHR	40.00	83,200
BUILDING LIGHTING	32400	KWHR	0.07	2,268
BUILDING HEATING OIL	500	GAL	1.00	500
MISCELLANEOUS ELECTRICAL	20000	KWHR	0.07	1,400
EXTRACTION WELL PUMP	33100	KWHR	0.07	2,317
LANDFILL GAS COLLECTION SYSTEM MAINTENANCE				
LABORER - 1 EA	8	MNHR	30.00	240
MATERIALS	1	LS	250.00	250
TWO YEAR REPORT TO DEP ANNUALIZED	0.4878	LS	1000.00	488
FIVE YEAR EDUCATIONAL PROGRAM PUBLIC MEETING - ANNUALIZED	0.1810	LS	5000.00	905
FIVE YEAR SITE REVIEW - ANNUALIZED	0.1810	LS	15000.00	2,715

UNDEVELOPED DESIGN DETAILS ~25%	85,417
TOTAL ANNUAL O&M COSTS	$426,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
COST SUMMARY TABLE

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
DIRECT COST OF ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW				
HYDROGEOLOGICAL STUDY				$126,000
SITE PREPARATION AND MOBILIZATION				134,000
DITCH AND LANDFILL COVER REPAIRS				611,000
EXTRACTION SYSTEM/DISCHARGE PIPE CONSTRUCTION				26,000
INSTITUTIONAL CONTROLS				13,000
TOTAL DIRECT COST OF ALTERNATIVE SHL-9: COLLECTION/ DISCHARGE TO POTW				$910,000
INDIRECT COST OF ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW				
HEALTH AND SAFETY			5.00%	$46,000
LEGAL, ADMIN, PERMITTING			5.00%	46,000
ENGINEERING			10.00%	91,000
SERVICES DURING CONSTRUCTION			10.00%	91,000
TOTAL INDIRECT COST OF ALTERNATIVE SHL-9: COLLECTION/ DISCHARGE TO POTW				$274,000
TOTAL CAPITAL (DIRECT + INDIRECT) COST				$1,184,000
OPERATING AND MAINTENANCE COSTS				
TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS				$175,000
TOTAL PRESENT WORTH OF ANNUAL O&M COSTS (5% FOR THIRTY YEARS)				$2,690,000
TOTAL COST OF ALTERNATIVE SHL-9: COLLECTION/ DISCHARGE TO POTW				$3,874,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
HYDROGEOLOGICAL STUDY				
MODELING, PERMEABILITY TESTS, WATER LEVELS, WELL INSTALLATION LABOR	1	LS	57000.00	$57,000
PIEZOMETER INSTALLATION	1	LS	44000.00	44,000
1 SINGLE				
4 NESTED PAIRS				
2 NESTED TRIPLETS				
UNDEVELOPED DESIGN DETAILS ~25%				25,000
TOTAL HYDROGEOLOGICAL STUDY				$126,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005–12
ALTERNATIVE SHL–9: COLLECTION/DISCHARGE TO POTW
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09–Sep–94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL–9: COLLECTION/DISCHARGE TO POTW
SITE PREPARATION AND MOBILIZATION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SITE PREPARATION				
STAGING AREA				
CLEAR & GRUB LIGHT VEGETATION	0.25	AC	3825.00	$956
GRADE	410	CY	2.00	820
GRAVEL – 12" THICK	1210	SY	3.50	4,235
PARKING AREA – USE EXISTING AREA – OK AS IS				
DECON AREA – USE EXISTING AREA – OK AS IS				
SURVEY	1	LS	25000.00	25,000
SUBTOTAL SITE PREPARATION				$31,011

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES
ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
JOB # 7005-12
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FT. DEVENS, MASSACHUSETTS
DATE 09-Sep-94
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
SITE PREPARATION AND MOBILIZATION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SITE PREPARATION - SHEET 9-3				$31,011
MOBILIZATION				
EQUIPMENT (IN OR OUT)				
FRONT END LOADER	2	EA	500.00	$1,000
DUMP TRUCK	2	EA	250.00	500
BACKHOE	2	EA	250.00	500
OFFICE TRAILER	2	MON	150.00	300
STORAGE TRAILER	2	MON	150.00	300
TRAILER DELIVERY, SET-UP, REMOVAL	2	EA	300.00	600
TOILET - 2 EA	16	WK	25.00	400
WATER COOLER - 2 EA	16	WK	25.00	400
WATER	80	DAY	15.00	1,200
TELEPHONE SERVICE	2	MON	500.00	1,000
ELECTRICITY	2	MON	250.00	500
PICK-UP	2	MON	1000.00	2,000
OFFICE EQUIPMENT	2	MON	1000.00	2,000
PUMPS, TOOLS, MINOR EQUIPMENT	1	LS	2500.00	2,500
LABORER (2 MEN*5 DAY/MAN*8 HR/DAY)	80	MNHR	30.00	2,400
CARPENTER (2 MEN*5 DAY/MAN*8 HR/DAY)	80	MNHR	38.00	3,040
ELECTRICIAN (2 MEN*5 DAY/MAN*8 HR/DAY)	80	MNHR	41.50	3,320
SITE SUPERINTENDANT (2 MON*210HR/MON)	420	MNHR	60.00	25,200
FOREMAN (2 MON*210HR/MON)	420	MNHR	50.00	21,000
CLERK/TYPIST (2 MON*168HR/MON)	336	MNHR	25.00	8,400
UNDEVELOPED DESIGN DETAILS ~25%				26,429
TOTAL SITE PREPARATION AND MOBILIZATION				$134,000

PROJECT:	FEASIBILITY STUDY FOR GROUP 1A SITES ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW	JOB #	7005-12
LOCATION:	SHEPLEY'S HILL LANDFILL OPERABLE UNIT FT. DEVENS, MASSACHUSETTS	DATE	09-Sep-94
ENGINEER:	ABB ENVIRONMENTAL SERVICES, INC.		
ESTIMATOR:	P. R. MARTIN		

ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
DITCH & LANDFILL COVER REPAIRS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
DITCH REPAIR				
CLEAN DITCH – BACKHOE & OPERATOR	2	DAY	1300.00	$2,600
LABORER – 2 EA	32	MNHR	30.00	960
DUMP TRUCK & DRIVER	2	DAY	665.00	1,330
RIPRAP – 1' THICKx15'Wx500'L	300	CY	30.00	9,000
LANDFILL COVER REPAIRS				
FILL & PATCH "POND" IN COVER				
BACKHOE & OPERATOR	5	DAY	1300.00	6,500
LABORER – 4 EA, 2 WKS/EA	320	MNHR	30.00	9,600
FILL MATERIAL	300	CY	20.00	6,000
GEOMEMBRANE	60000	SF	0.35	21,000
VIBRATORY PLATE COMPACTOR	5	DAY	60.00	300
10-3 DRAINAGE SAND	1100	CY	8.00	8,800
FILTER FABRIC	60000	SF	0.16	9,600
1' VEGETATIVE COVER	1200	CY	7.50	9,000
SEED, FERTILIZE, MULCH	2	AC	2000.00	4,000
SPREAD & COMPACT, EQUIP & OPER	5	DAY	1450.00	7,250
EVALUATION/IMPROVEMENT OF STORMWATER DIVERSION AND DRAINAGE				
EVALUATION OF LANDFILL CAP RUNOFF PATTERNS, DITCH CAPACITIES, STORMWATER DRAINAGE SYSTEMS UPGRADIENT OF LANDFILL AND, RUN-UNDER ALONG WESTERN EDGE OF LANDFILL	1	LS	43000.00	43,000
REPLACE/INSTALL STORM SEWERS/DRAINS				
18" DIA RCP	800	LF	45.00	36,000
24" DIA RCP	800	LF	55.00	44,000
36" DIA RCP	1600	LF	100.00	160,000
REDUCE RUN-UNDER ALONG WESTERN EDGE	1	LS	90000.00	90,000
MONITORING WELL DRILLING	3	EA	6600.00	19,800
UNDEVELOPED DESIGN DETAILS ~25%				122,260
TOTAL DITCH & LANDFILL COVER REPAIRS				$611,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
EXTRACTION SYSTEM/DISCHARGE PIPE CONSTRUCTION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
EXTRACTION SYSTEM CONSTRUCTION				
6" EXTRACTION WELL	1	EA	6700.00	$6,700
2 HP PUMP & CONTROLS	1	EA	3500.00	3,500
3"/1.5" PE CONTAINMENT/FORCE MAIN	500	LF	20.00	10,000
CONNECT TO EXISTING MANHOLE	1	LS	500.00	500
UNDEVELOPED DESIGN DETAILS ~25%				5,300
TOTAL EXTRACTION SYSTEM/DISCHARGE PIPE CONSTRUCTION				$26,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT — DATE 09-Sep-94
FT. DEVENS, MASSACHUSETTS
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
INSTITUTIONAL CONTROLS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
INSTITUTIONAL CONTROLS	1	LS	10000.00	$10,000
UNDEVELOPED DESIGN DETAILS ~25%				3,000
TOTAL INSTITUTIONAL CONTROLS				$13,000

APPENDIX B

PROJECT:	FEASIBILITY STUDY FOR GROUP 1A SITES ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW	JOB #	7005-12
LOCATION:	SHEPLEY'S HILL LANDFILL OPERABLE UNIT FT. DEVENS, MASSACHUSETTS	DATE	09-Sep-94
ENGINEER:	ABB ENVIRONMENTAL SERVICES, INC.		
ESTIMATOR:	P. R. MARTIN		

ALTERNATIVE SHL-9: COLLECTION/DISCHARGE TO POTW
ANNUAL O&M COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
LANDFILL COVER MAINTENANCE				
GENERAL REPAIR				
DUMP TRUCK & DRIVER	1	DAY	665.00	$665
FRONT END LOADER & OPERATOR	1	DAY	800.00	800
LABORER - 2 EA	16	MNHR	30.00	480
MATERIALS	1	LS	500.00	500
INSPECTION - 2 DAY @ 2 MEN/DAY	32	MNHR	75.00	2,400
MOWING - TRACTOR & OPERATOR	4	DAY	500.00	2,000
EFFLUENT GROUNDWATER WEEKLY MONITORING				
VOCs	52	SMPL	300.00	15,600
INORGANICS	52	SMPL	270.00	14,040
GROUNDWATER MONITORING 14 WELLS, SEMI-ANNUALLY	2	EVENT	8560.00	17,120
GROUNDWATER SAMPLE ANALYSIS 14 SAMPLES PLUS 3 SAMPLE QA/QC EQUIVALENT SEMI-ANNUALLY, VOCs, INORGANICS, WATER QUALITY PARAMETERS	34	SMPL	785.00	26,690
LANDFILL GAS MONITORING 18 POINTS, QUARTERLY AND ANALYSIS	4	EVENT	3000.00	12,000
AYER WWTP FEE	21080	CCF	2.00	42,160
EXTRACTION WELL PUMP	13070	KWHR	0.07	915
LANDFILL GAS COLLECTION SYSTEM MAINTENANCE				
LABORER - 1 EA	8	MNHR	30.00	240
MATERIALS	1	LS	250.00	250
TWO YEAR REPORT TO DEP - ANNUALIZED	0.4878	LS	1000.00	488
FIVE YEAR EDUCATIONAL PROGRAM				
PUBLIC MEETING - ANNUALIZED	0.1810	LS	5000.00	905
FIVE YEAR SITE REVIEW - ANNUALIZED	0.1810	LS	15000.00	2,715
UNDEVELOPED DESIGN DETAILS ~25%				35,033
TOTAL ANNUAL O&M COSTS				$175,000

APPENDIX B

PROJECT:	FEASIBILITY STUDY FOR GROUP 1A SITES ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP	JOB #	7005-12
LOCATION:	SHEPLEY'S HILL LANDFILL OPERABLE UNIT FT. DEVENS, MASSACHUSETTS	DATE	12-Sep-94
ENGINEER:	ABB ENVIRONMENTAL SERVICES, INC.		
ESTIMATOR:	P. R. MARTIN		

ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
COST SUMMARY TABLE

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
DIRECT COST OF ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP				
MOBILIZATION				$281,000
COVER SYSTEM				14,817,000
INSTITUTIONAL CONTROLS				13,000
TOTAL DIRECT COST OF ALTERNATIVE SHL-10: INSTALLTION OF RCRA CAP				$15,111,000
INDIRECT COST OF ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP				
HEALTH AND SAFETY			5.00%	$756,000
LEGAL, ADMIN, PERMITTING			5.00%	756,000
ENGINEERING			10.00%	1,511,000
SERVICES DURING CONSTRUCTION			10.00%	1,511,000
TOTAL INDIRECT COST OF ALTERNATIVE SHL-10: INSTALLTION OF RCRA CAP				$4,534,000
TOTAL CAPITAL (DIRECT + INDIRECT) COST				$19,645,000
OPERATING AND MAINTENANCE COSTS				
TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS				$84,000
TOTAL PRESENT WORTH OF ANNUAL O&M COSTS (5% FOR THIRTY YEARS)				$1,291,000
TOTAL COST OF ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP				$20,936,000

APPENDIX B

PROJECT:	FEASIBILITY STUDY FOR GROUP 1A SITES ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP	JOB #	7005-12
LOCATION:	SHEPLEY'S HILL LANDFILL OPERABLE UNIT FT. DEVENS, MASSACHUSETTS	DATE	12-Sep-94
ENGINEER:	ABB ENVIRONMENTAL SERVICES, INC.		
ESTIMATOR:	P. R. MARTIN		

ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
SITE PREPARATION & MOBILIZATION

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
SITE PREPARATION				
STAGING AREA				
CLEAR & GRUB LIGHT VEGETATION	15	AC	3825.00	$57,375
GRADE	15	AC	3300.00	49,500
GRAVEL - 12" THICK	1210	SY	3.50	4,235
PARKING AREA - USE EXISTING AREA - OK AS IS				
DECON AREA - USE EXISTING AREA - OK AS IS				
SURVEY	1	LS	25000.00	25,000
MOBILIZATION - EQUIPMENT (IN OR OUT)				
DOZER	4	EA	1500.00	6,000
DUMP TRAILER - 20 CY	14	EA	800.00	11,200
FRONT END LOADER	4	EA	1250.00	5,000
DUMP TRUCK - 12 CY	4	EA	675.00	2,700
BACKHOE	4	EA	1500.00	6,000
COMPACTOR	28	EA	700.00	19,600
OFFICE TRAILER	1	MON	150.00	150
STORAGE TRAILER	1	MON	150.00	150
TRAILER DELIVERY, SET-UP, REMOVAL	2	EA	300.00	600
TOILET	4	WK	25.00	100
WATER COOLER	4	WK	25.00	100
WATER	20	DAY	15.00	300
TELEPHONE SERVICE	1	MON	500.00	500
ELECTRICITY	1	MON	250.00	250
PICK-UP	1	MON	1000.00	1,000
OFFICE EQUIPMENT	1	MON	1000.00	1,000
PUMPS, TOOLS, MINOR EQUIPMENT	1	LS	2500.00	2,500
LABORER (1 MAN*5 DAY/MAN*8 HR/DAY)	40	MNHR	30.00	1,200
CARPENTER (1 MAN*5 DAY/MAN*8 HR/DAY)	40	MNHR	38.00	1,520
ELECTRICIAN (1 MAN*5 DAY/MAN*8 HR/DAY)	40	MNHR	41.50	1,660
SITE SUPERINTENDANT (1 MON*210HR/MON)	210	MNHR	60.00	12,600
FOREMAN (1 MON*210HR/MON)	210	MNHR	50.00	10,500
CLERK/TYPIST (1 MON*168HR/MON)	168	MNHR	25.00	4,200
UNDEVELOPED DESIGN DETAILS ~25%				56,060
TOTAL MOBILIZATION				$281,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FT. DEVENS, MASSACHUSETTS — DATE 12-Sep-94
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
COVER SYSTEM

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
TEST PITTING/BORINGS TO CONFIRM LIMITS OF WASTE	1	LS	20000.00	$20,000
BORROW STUDY	1	LS	5000.00	5,000
STRIP AND STOCKPILE EXISTING MATERIALS TOPSOIL	67760	CY	3.75	254,100
BUILD-UP TO ACHIEVE 3% FINAL GRADE	120000	CY	8.00	960,000
CONTOUR TO ACHIEVE FINAL GRADE	30	AC	2500.00	75,000
COMPACTION	30	AC	3500.00	105,000
GAS VENT LAYER (USE EXISTING SYSTEM)	0	CY	14.00	0
GAS VENT PIPING, 4" DIA (USE EXISTING SYSTEN	0	LF	5.00	0
EXTEND GAS VENT RISERS	18	EA	500.00	9,000

TOTAL THIS PAGE $1,428,100

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FT. DEVENS, MASSACHUSETTS — DATE 12-Sep-94
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP

COVER SYSTEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
TOTAL PAGE SHL10-3				$1,428,100
CUSHION LAYER	67760	CY	14.00	948,640
GEOSYNTHETIC CLAY LINER	84	AC	30000.00	2,520,000
GEOMEMBRANE, 40 MIL VLDPE	84	AC	20000.00	1,680,000
DRAINAGE LAYER	135520	CY	14.00	1,897,280
GEOTEXTILE	84	AC	5000.00	420,000
BUFFER/FILTER LAYER	135520	CY	10.00	1,355,200
TOPSOIL LAYER				
REUSE STOCKPILED MATERIAL	67760	CY	7.00	474,320
NEW MATERIAL	67760	CY	10.00	677,600
RIPRAP DRAINAGE DITCHES, 1' THICK	833	CY	30.00	24,990
REPLACE/INSTALL STORM SEWERS/DRAINS				
18" DIA RCP	800	LF	45.00	36,000
24" DIA RCP	800	LF	55.00	44,000
36" DIA RCP	1600	LF	100.00	160,000
FERTILIZE, SEED, MULCH	84	AC	2000.00	168,000
MONITORING WELL DRILLING	3	EA	6600.00	19,800
UNDEVELOPED DESIGN DETAILS ~25%				2,963,070
TOTAL COVER SYSTEM				$14,817,000

APPENDIX B

PROJECT:	FEASIBILITY STUDY FOR GROUP 1A SITES ALTERNATIVE SHL–10: INSTALLATION OF RCRA CAP	JOB #	7005–12
LOCATION:	SHEPLEY'S HILL LANDFILL OPERABLE UNIT FT. DEVENS, MASSACHUSETTS	DATE	12–Sep–94
ENGINEER:	ABB ENVIRONMENTAL SERVICES, INC.		
ESTIMATOR:	P. R. MARTIN		

ALTERNATIVE SHL–10: INSTALLATION OF RCRA CAP
INSTITUTIONAL CONTROLS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
INSTITUTIONAL CONTROLS	1	LS	10000.00	$10,000
UNDEVELOPED DESIGN DETAILS ~25%				3,000
TOTAL INSTITUTIONAL CONTROLS				$13,000

APPENDIX B

PROJECT: FEASIBILITY STUDY FOR GROUP 1A SITES — JOB # 7005-12
ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
LOCATION: SHEPLEY'S HILL LANDFILL OPERABLE UNIT
FT. DEVENS, MASSACHUSETTS — DATE 12-Sep-94
ENGINEER: ABB ENVIRONMENTAL SERVICES, INC.

ESTIMATOR: P. R. MARTIN

ALTERNATIVE SHL-10: INSTALLATION OF RCRA CAP
ANNUAL O&M COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
LANDFILL COVER MAINTENANCE				
GENERAL REPAIR				
DUMP TRUCK & DRIVER	1	DAY	665.00	$665
FRONT END LOADER & OPERATOR	1	DAY	800.00	800
LABORER - 2 EA	16	MNHR	30.00	480
MATERIALS	1	LS	500.00	500
INSPECTION - 2 DAY @ 2 MEN/DAY	32	MNHR	75.00	2,400
MOWING - TRACTOR & OPERATOR	4	DAY	500.00	2,000
GROUNDWATER MONITORING	2	EVENT	8560.00	17,120
14 WELLS, SEMI-ANNUALLY				
GROUNDWATER SAMPLE ANALYSIS	34	SMPL	785.00	26,690
14 SAMPLES PLUS 3 SAMPLE QA/QC EQUIVALENT				
SEMI-ANNUALLY, VOCs, INORGANICS, WATER QUALITY PARAMETERS				
LANDFILL GAS MONITORING	4	EVENT	3000.00	12,000
18 POINTS, QUARTERLY AND ANALYSIS				
LANDFILL GAS COLLECTION SYSTEM MAINTENANCE				
LABORER - 1 EA	8	MNHR	30.00	240
MATERIALS	1	LS	250.00	250
TWO YEAR REPORT TO DEP - ANNUALIZED	0.4878	LS	1000.00	488
FIVE YEAR EDUCATIONAL PROGRAM				
PUBLIC MEETING - ANNUALIZED	0.1810	LS	5000.00	905
FIVE YEAR SITE REVIEW - ANNUALIZED	0.1810	LS	15000.00	2,715
UNDEVELOPED DESIGN DETAILS ~25%				16,748
TOTAL ANNUAL O&M COSTS				$84,000

APPENDIX C

APPENDIX C

CALCULATIONS OF INFLUENT CONCENTRATIONS

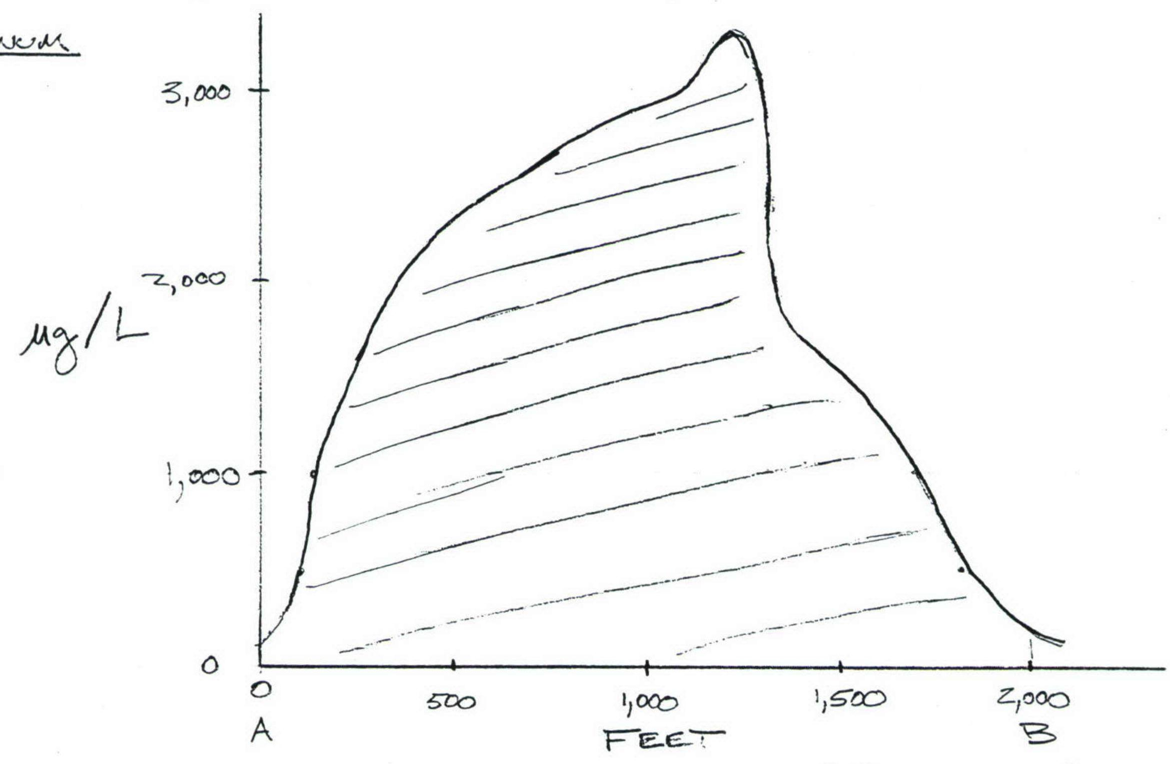
PROJECT	COMP. BY	JOB NO.
TREATMENT PLANT INFLUENT CONCENTRATIONS – SHEPLEY'S HILL LANDFILL	JSM	7005-07
	CHK. BY	DATE
	SNP	8/11/93

REFERENCE: COST OF REMEDIAL ACTION MODEL, VERSION 3.0
SECTION 4 OF USERS MANUAL
"ESTIMATING CONCENTRATION IN RECOVERY WELLS"

ASSUMPTIONS:
1. PRODUCTION RATE IS UNIFORM THROUGHOUT THE LENGTH OF THE WELL SCREEN.
2. FLOW TO WELL IS STEADY AND DISPERSIVE EFFECTS IGNORED.
3. CONTAMINANT CONCENTRATIONS ARE UNIFORM THROUGHOUT THE LENGTH OF THE WELL SCREEN.
4. NO BIOCHEMICAL TRANSFORMATION OF CONTAMINANTS.
5. CALCULATED INFLUENT CONCENTRATIONS ARE DERIVED FROM MONITORING DATA WHICH REPRESENTS A GENERAL TREND OF CONTAMINATION IN A CROSS-SECTION ACROSS THE SITE.

SEQUENCE FOR EXTRACTION WELL INFLUENT CONCENTRATIONS:
1) PLOT CONCENTRATION CONTOURS ON SITE FIGURE.
2) PLOT CONCENTRATION VS. LENGTH OF CROSS-SECTION.
3) MEASURE AREA UNDER CURVE USING A PLANIMETER.
4) DIVIDE AREA UNDER CURVE BY CROSS-SECTION LENGTH
⟹ YIELDING WEIGHTED AVERAGE CONCENTRATIONS

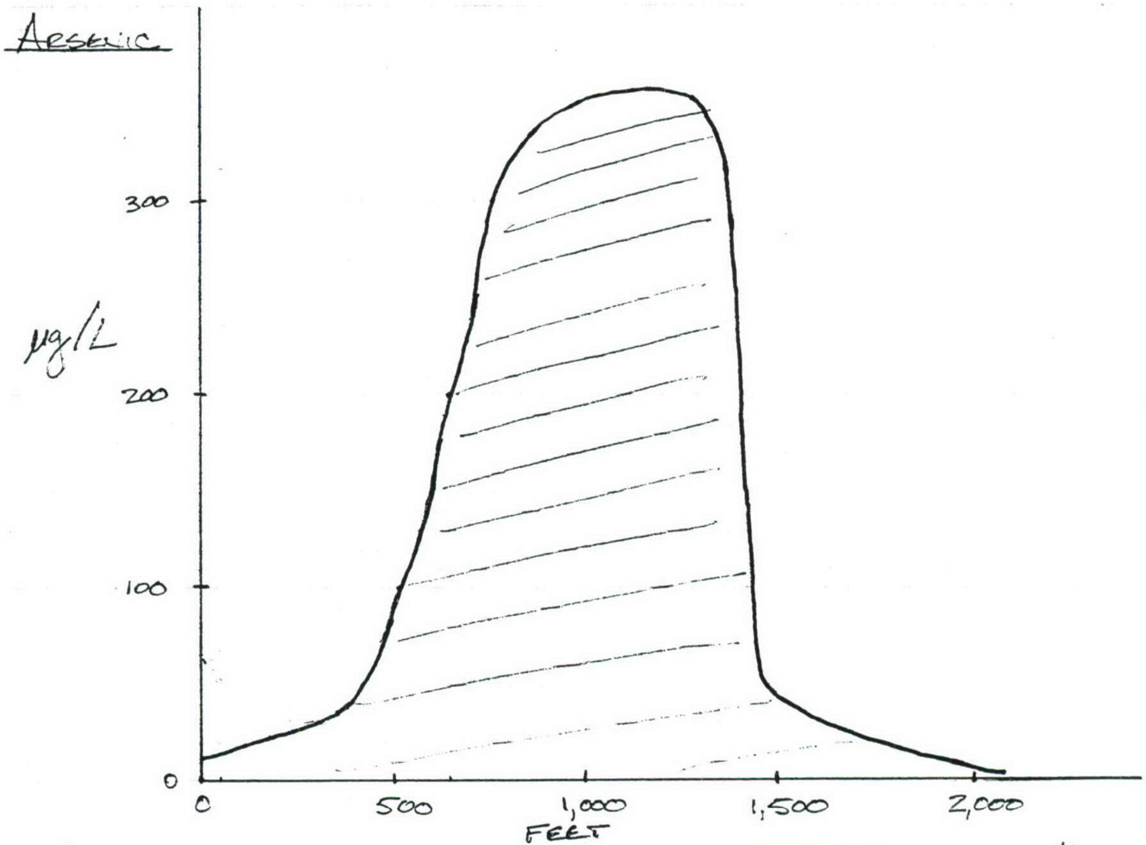
ALUMINUM



USING PLANIMETER, AREA UNDER CURVE = 3,735,507 FT-µg/L
⟹ ALUMINUM INFLUENT CONCENTRATION = 3,735,507/2,000 = 1,867 µg/L

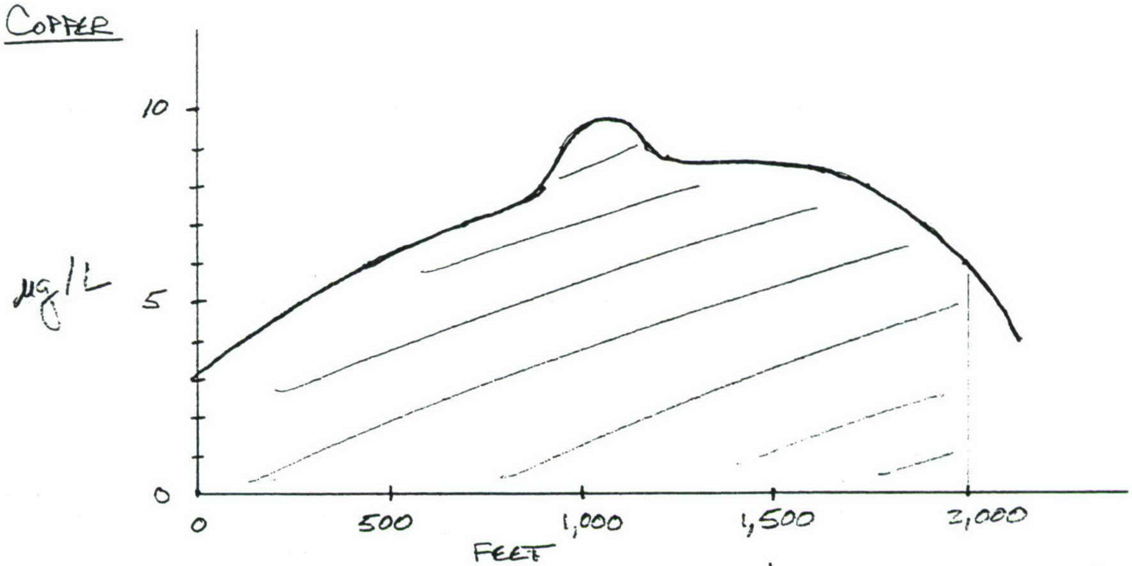
PROJECT	COMP. BY	JOB NO.
	JSM	7005-07
	CHK. BY	DATE
	SW?	8/11/93

ARSENIC



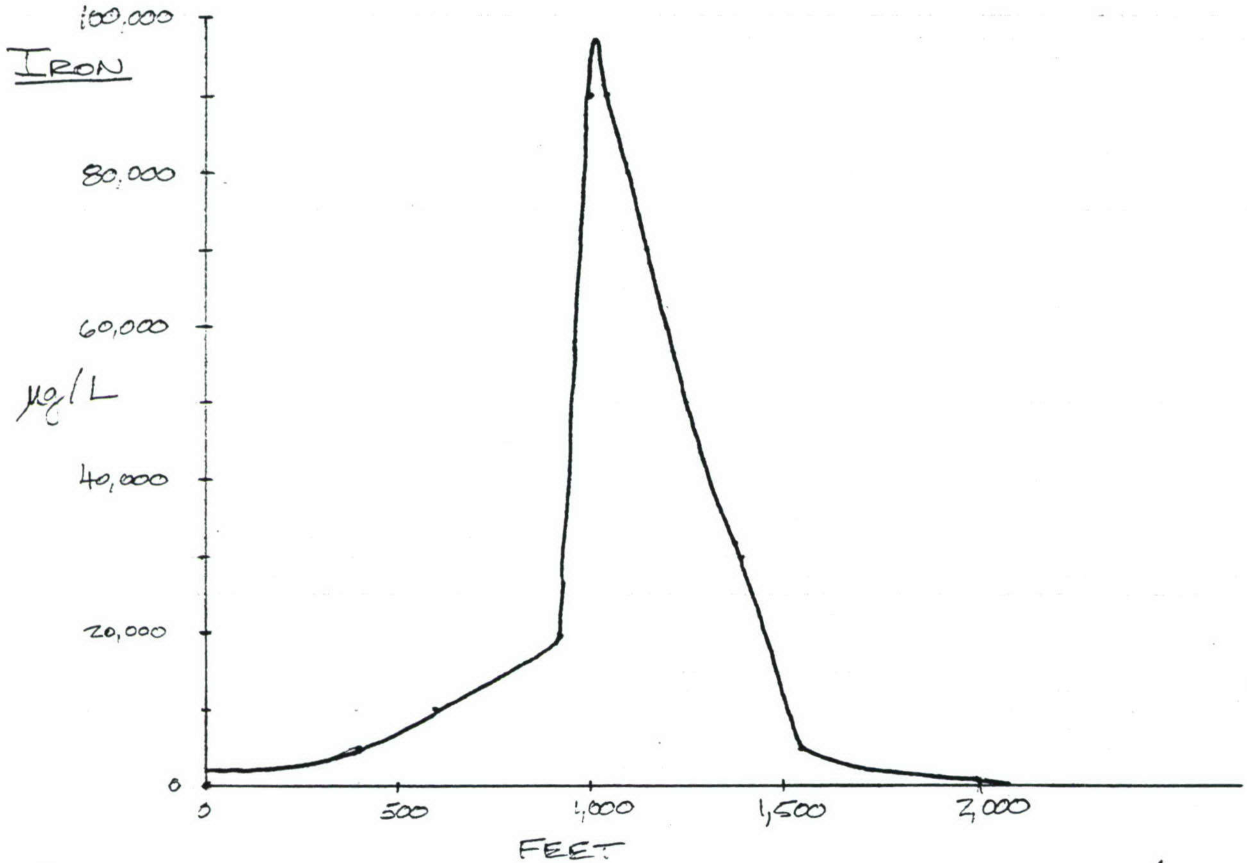
USING PLANIMETER, AREA UNDER CURVE = 299,150 FT-µg/L
⟹ ARSENIC INFLUENT CONCENTRATION = 299,150/2,000
= 150 µg/L

COPPER

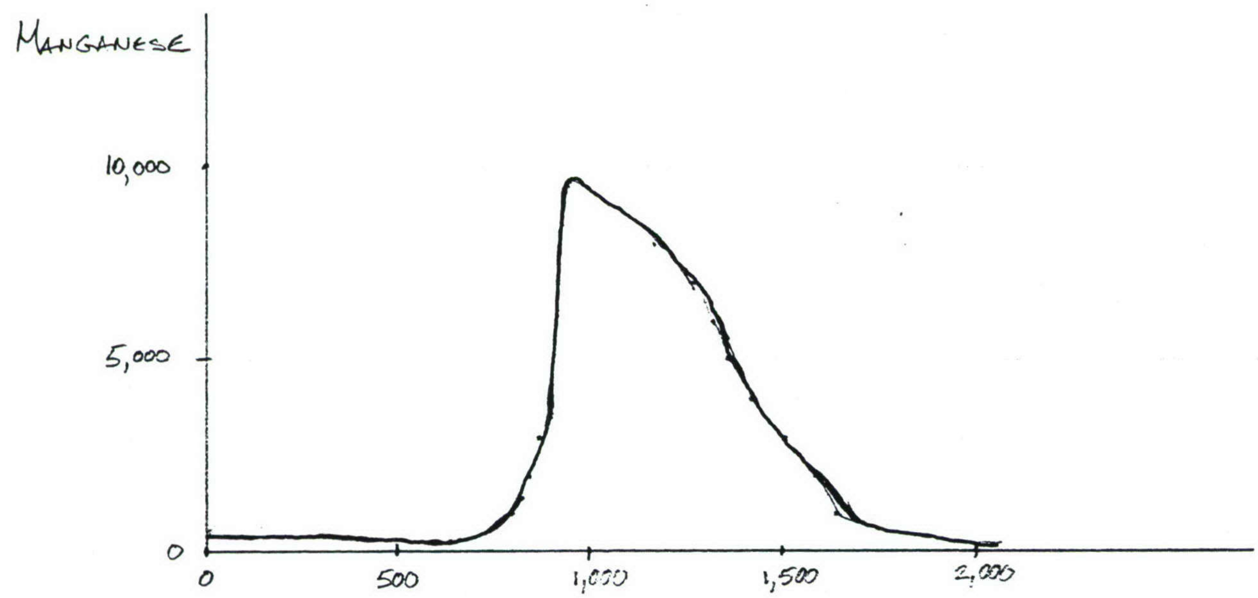


USING PLANIMETER, AREA UNDER CURVE = 14,550 FT-µg/L
⟹ COPPER INFLUENT CONCENTRATION = 14,550/2,000 ≅ 7.3 µg/L

PROJECT	COMP. BY	JOB NO.
	JSM	7005-07
	CHK. BY	DATE
	SNP	8/11/93



USING PLANIMETER, AREA UNDER CURVE = 30,612,561 FT-μg/L
⇒ IRON INFLUENT CONCENTRATION = 15,306 μg/L

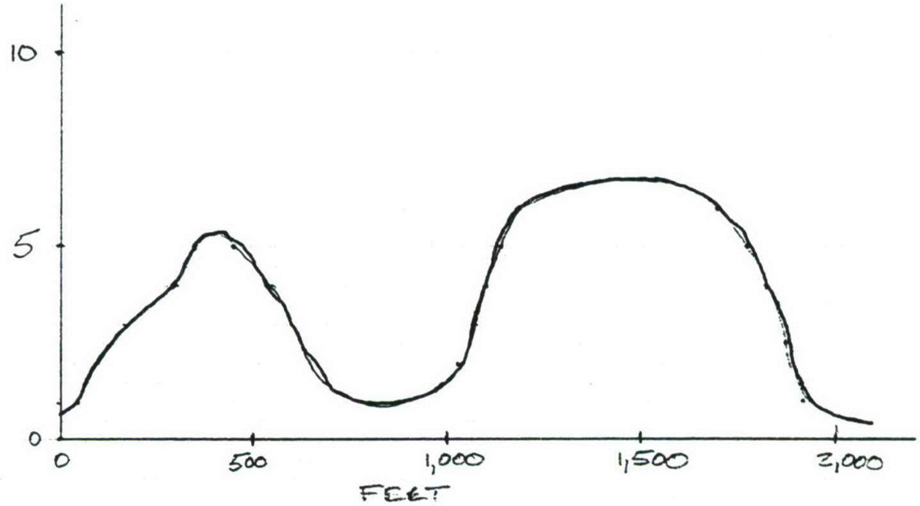


USING PLANIMETER, AREA UNDER CURVE = 5,270,010 FT-μg/L
⇒ MANGANESE CONCENTRATION = 2,635 μg/L

PAGE 4

PROJECT	COMP. BY	JOB NO.
	JSM	7005-07
	CHK. BY	DATE
	SNP	8/11/93

LEAD



USING PLANIMETER, AREA UNDER CURVE = 7,672 FT-μg/L
⇒ LEAD INFLUENT CONCENTRATION = 7,672 / 2,000 = 3.8 μg/L

IN SUMMARY:

CONTAMINANT	TREATMENT PLANT INFLUENT CONCENTRATIONS
ALUMINUM	1,870 μg/L
ARSENIC	150
COPPER	7.3
IRON	15,306
MANGANESE	2,635
LEAD	3.8

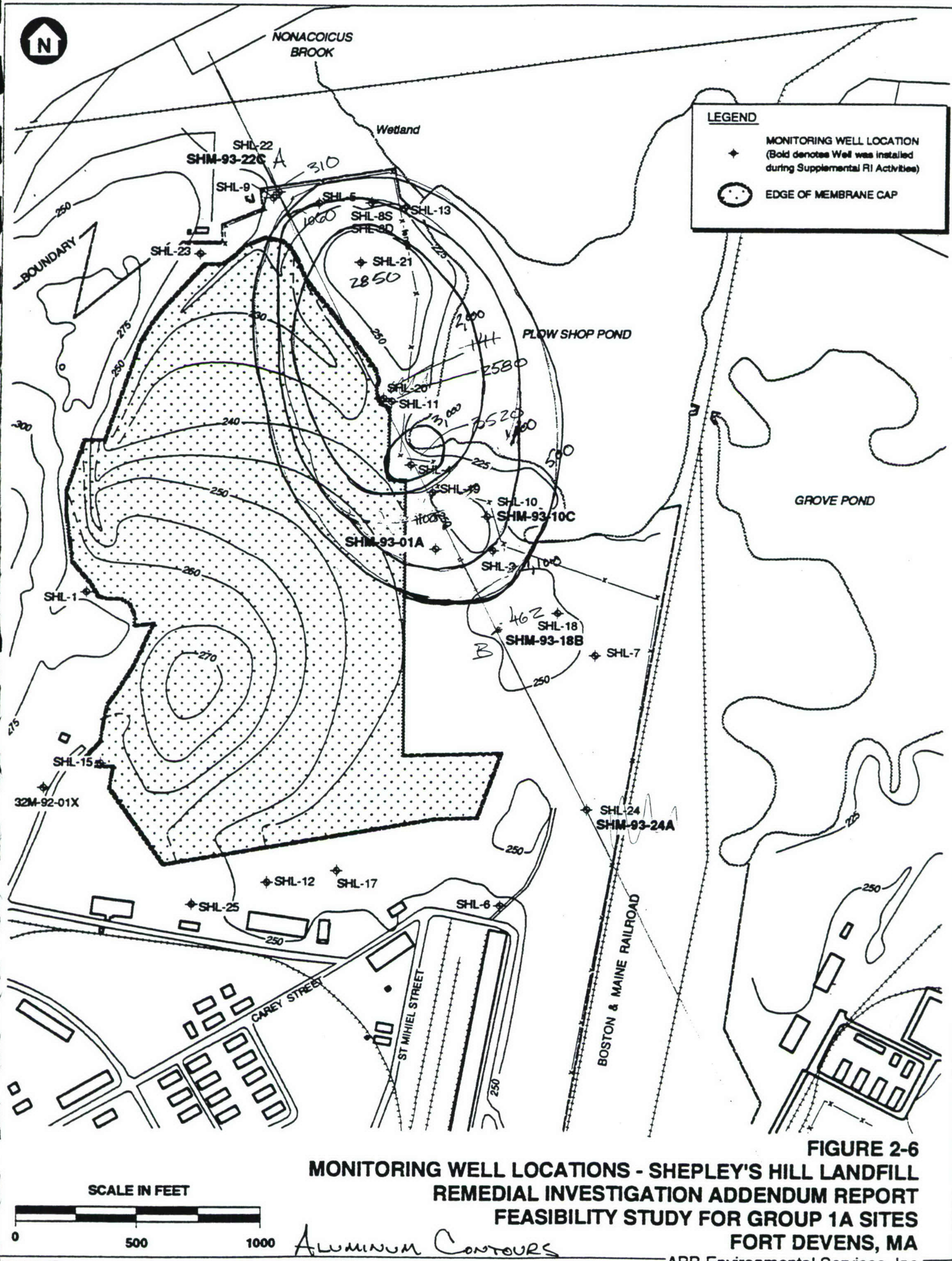


FIGURE 2-6
MONITORING WELL LOCATIONS - SHEPLEY'S HILL LANDFILL
REMEDIAL INVESTIGATION ADDENDUM REPORT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

ALUMINUM CONTOURS

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PAGE 6

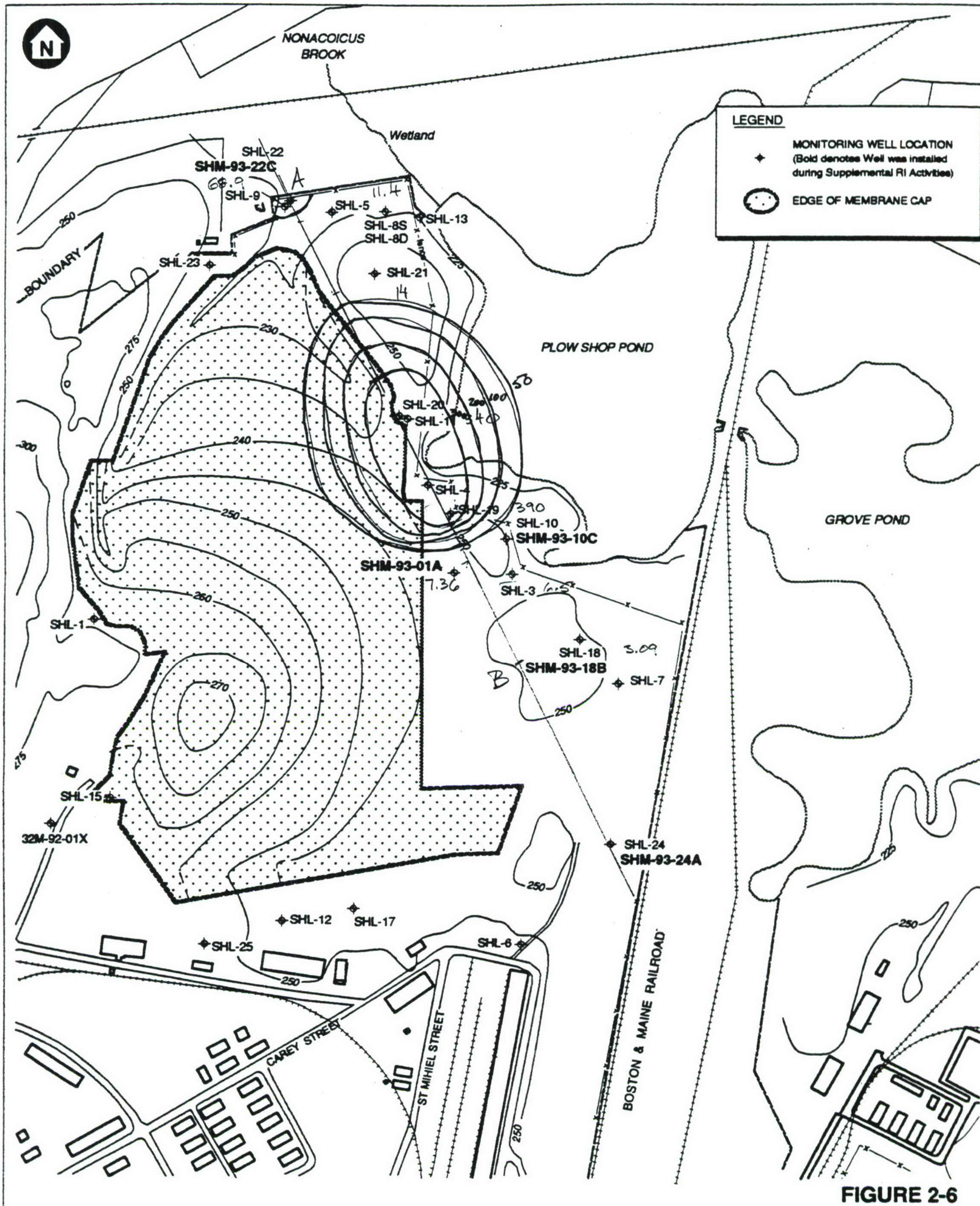


FIGURE 2-6
MONITORING WELL LOCATIONS - SHEPLEY'S HILL LANDFILL
REMEDIAL INVESTIGATION ADDENDUM REPORT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA
ABB Environmental Services, Inc.

ARSENIC CONTOURS

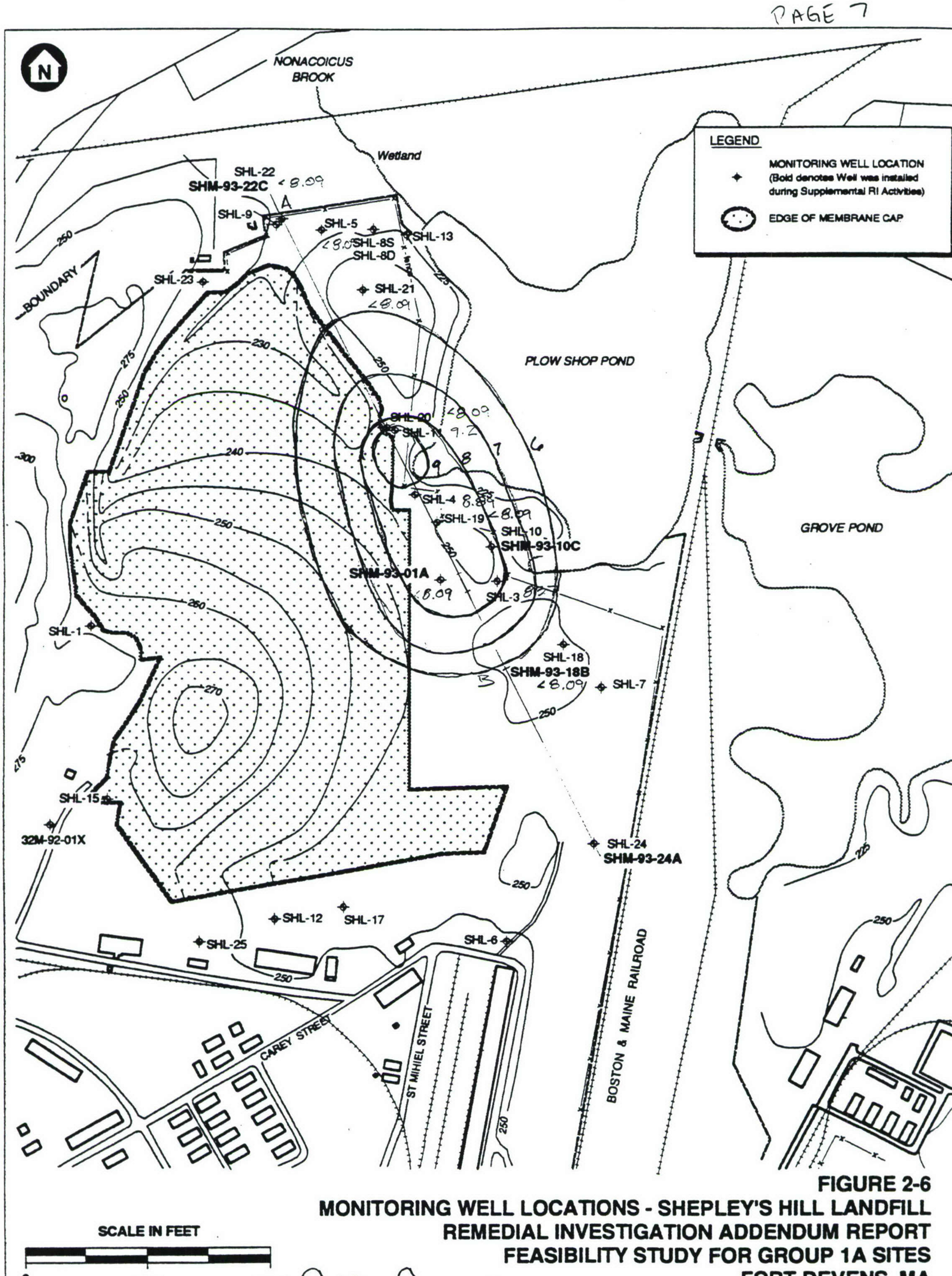


FIGURE 2-6
MONITORING WELL LOCATIONS - SHEPLEY'S HILL LANDFILL
REMEDIAL INVESTIGATION ADDENDUM REPORT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA
ABB Environmental Services, Inc.

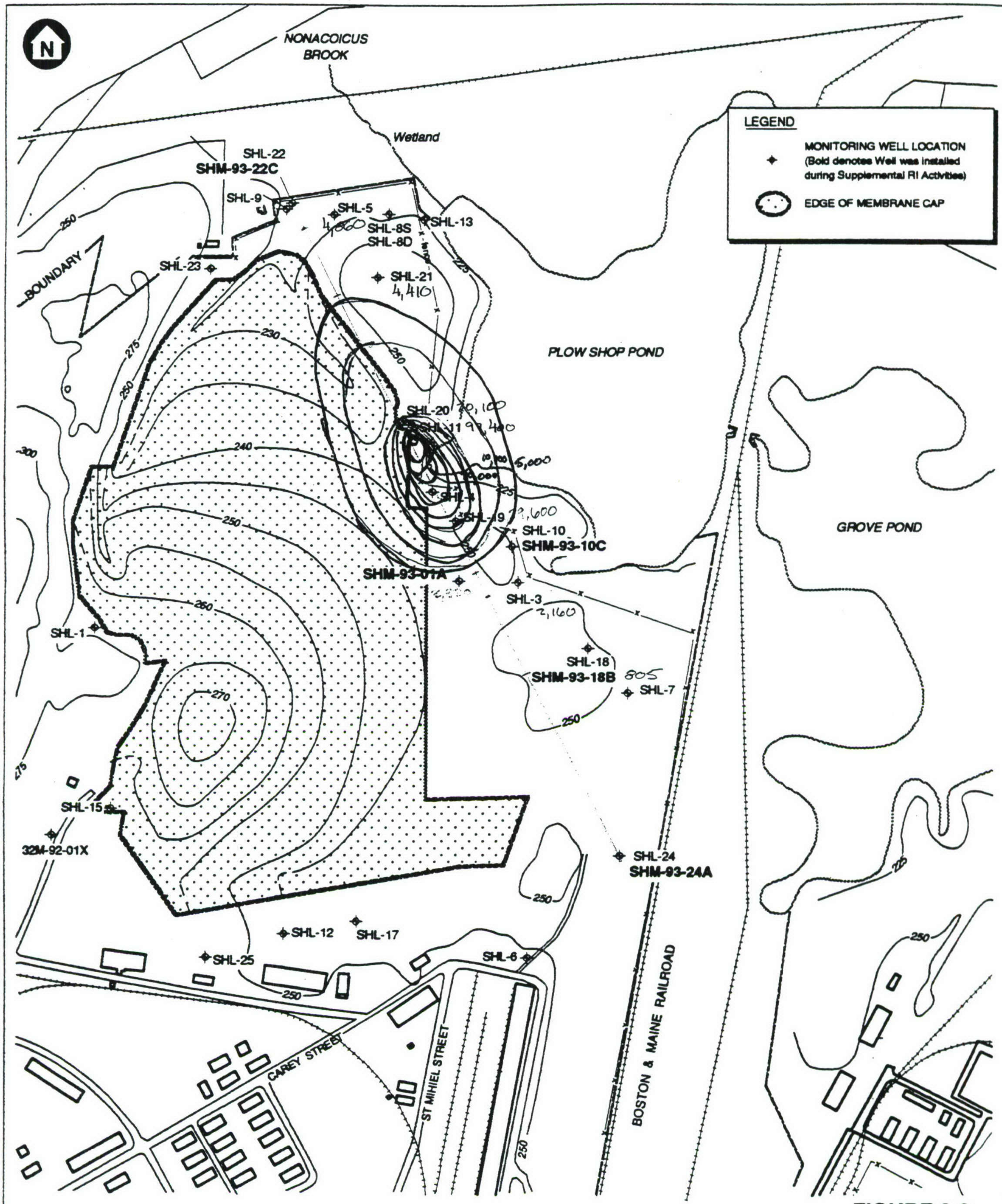


FIGURE 2-6
MONITORING WELL LOCATIONS - SHEPLEY'S HILL LANDFILL
REMEDIAL INVESTIGATION ADDENDUM REPORT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA

SCALE IN FEET
0 500 1000

IRON CONTOURS

ABB Environmental Services, Inc.

9303022D01ST

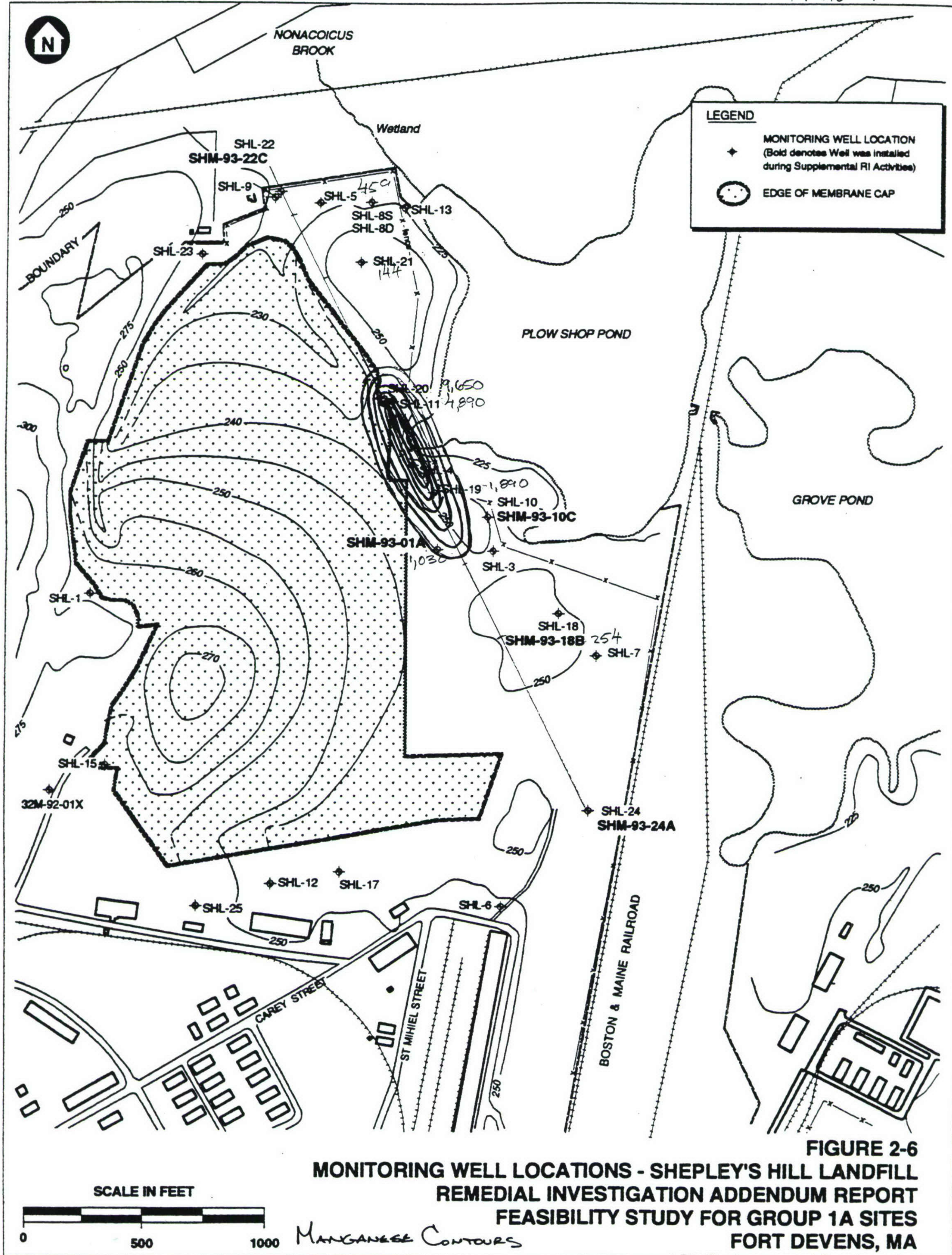
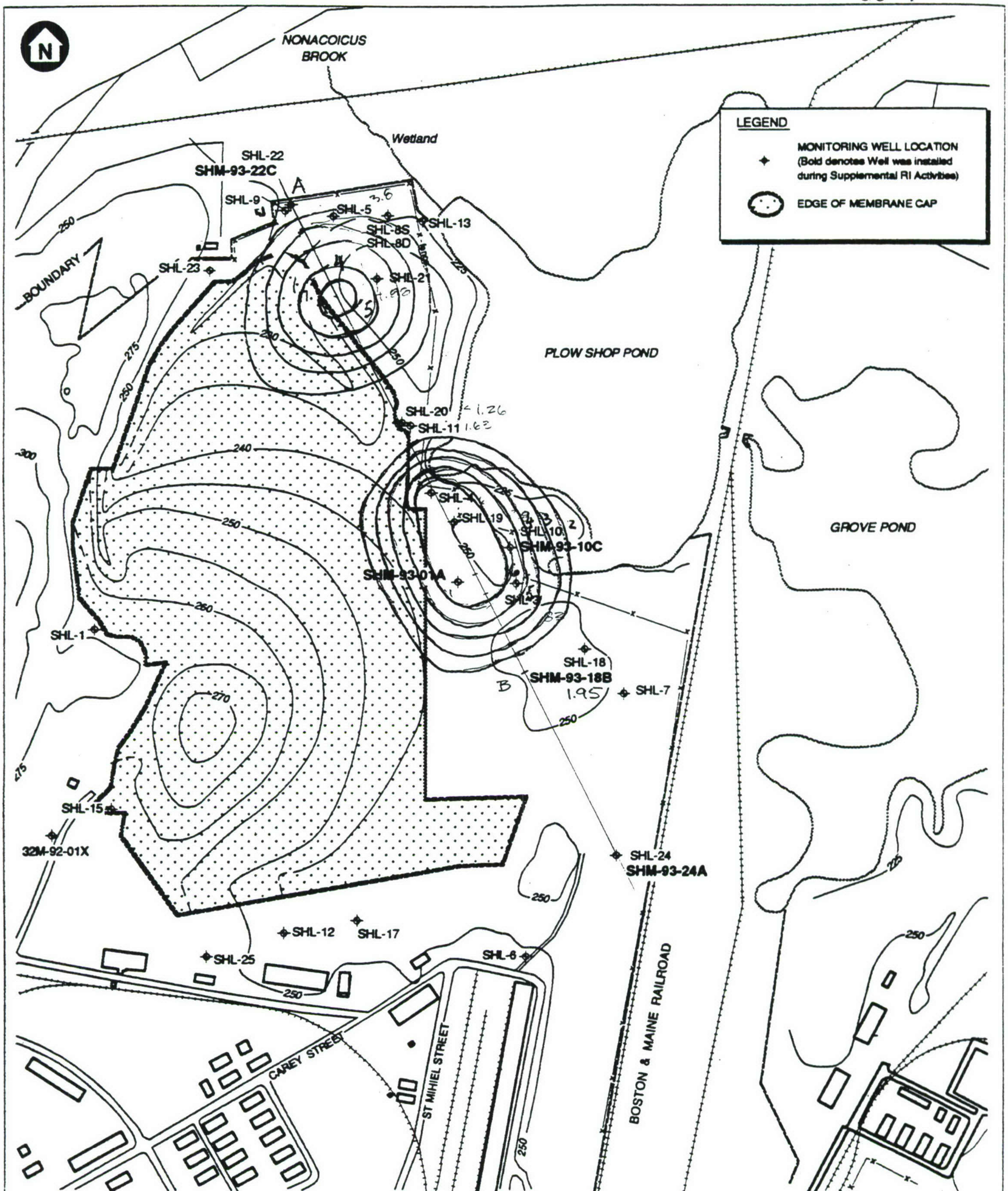


FIGURE 2-6
MONITORING WELL LOCATIONS - SHEPLEY'S HILL LANDFILL
REMEDIAL INVESTIGATION ADDENDUM REPORT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA
ABB Environmental Services, Inc.

9303022D1ST

PAGE 10



SCALE IN FEET

0 500 1000

LEAD CONTOURS

FIGURE 2-6
MONITORING WELL LOCATIONS - SHEPLEY'S HILL LANDFILL
REMEDIAL INVESTIGATION ADDENDUM REPORT
FEASIBILITY STUDY FOR GROUP 1A SITES
FORT DEVENS, MA
ABB Environmental Services, Inc.

9303022D1ST

APPENDIX D

APPENDIX D

CALCULATIONS OF DISCHARGE LIMITS

Calculation of Discharge Limitations

Backcalculate to prevent exceedances of AWQC in Nonacoicus Brook.

Ce = allowable effluent concentration
AWQC = Ambient water quality criteria, fresh water chronic, see backup calcs.
7Q10 = 7 day 10-year low flow in Nonacoicus Brook
Cb = ambient concentration in brook (i.e., sample SW-SHL-15)
Qe = effluent flow
SQL = sample quantitation limit

$$Ce = \frac{(AWQC)(7Q10 + Qe) - (7Q10)(Cb)}{Qe}$$

Aluminum

AWQC	=	87 ug/L	Ce30=	1876 ug/L
7Q10	=	1167 gpm	Ce60=	982 ug/L
Cb	=	41 ug/L		
Qe30	=	30 gpm		Cb is one-half the SQL
Qe60	=	60 gpm		

Arsenic

AWQC	=	190 ug/L	Ce30=	7445 ug/L
7Q10	=	1167 gpm	Ce60=	3817 ug/L
Cb	=	3.5 ug/L		fresh water chronic
Qe30	=	30 gpm		Cb is one-half the SQL
Qe60	=	60 gpm		

Chromium

AWQC	=	88 ug/L	Ce30=	3422 ug/L
7Q10	=	1167 gpm	Ce60=	1755 ug/L
Cb	=	2.3 ug/L		
Qe30	=	30 gpm		Cb is one-half the SQL
Qe60	=	60 gpm		

Copper

AWQC	=	4.8 ug/L	Ce30=	102 ug/L
7Q10	=	1167 gpm	Ce60=	53 ug/L
Cb	=	2.3 ug/L		
Qe30	=	30 gpm		Cb is one-half SQL
Qe60	=	60 gpm		

Manganese

AWQC	=	1000 ug/L	Ce30=	20839 ug/L	
7Q10	=	1167 gpm	Ce60=	10920 ug/L	
Cb	=	490 ug/L		1000 from McKee and Wolf 1963	
Qe30	=	30 gpm		Cb = observed in SW−SHL−15	
Qe60	=	60 gpm			

Nickel

AWQC	=	65 ug/L	Ce30=	2251 ug/L
7Q10	=	1167 gpm	Ce60=	1158 ug/L
Cb	=	8.8 ug/L		
Qe30	=	30 gpm		
Qe60	=	60 gpm		

Iron

AWQC	=	1000 ug/L	Ce30=	25235 ug/L
7Q10	=	1167 gpm	Ce60=	13117 ug/L
Cb	=	377 ug/L		
Qe30	=	30 gpm		fresh water chronic
Qe60	=	60 gpm		Cb = avg in Plow Shop Pond

Lead

AWQC	=	0.85 ug/L	Ce30=	−59 ug/L
7Q10	=	1167 gpm	Ce60=	−29 ug/L
Cb	=	2.4 ug/L		
Qe30	=	30 gpm		Cb is one−half the SQL
Qe60	=	60 gpm		

PROJECT	COMP. BY	JOB NO.
Shepley's Hill Landfill FS	SNP	7005-04
AWQC values - Discharge Limitations	CHK. BY	DATE 3/4/94

Based on the water quality criteria Summary Concentrations published by U.S. EPA - May 1, 1991

Aluminum - see 53 FR 33178

according to above guidance use 87 μg/L

Arsenic - freshwater chronic criteria is 190 μg/L

Chromium - the freshwater chronic criteria in the above mentioned guidance is based on a Hardness of 100 mg/L
Actual Hardness values are ~35 mg $CaCO_3$/L
according to 50 FR 30788, the 4 day average concentration in μg/L of Chromium(III) can not exceed

$$Cr = e(0.8190[\ln[\text{Hardness}]+1.561)$$
$$Cr = e(0.8190[\ln 35]+1.561)$$
$$Cr = 88\ \mu g/L$$

Copper - Similar to chromium, according to 50 FR 30789, the 4 day average concentration in μg/L of copper can not exceed

$$Cu = e(0.8545[\ln \text{hardness}]-1.465)$$
$$Cu = e(0.8545(\ln 35)-1.465)$$
$$Cu = 4.8\ \mu g/L$$

Iron - freshwater chronic criteria is 1000 μg/L

PROJECT	COMP. BY SNP	JOB NO. 7005-04
	CHK. BY	DATE 3/4/94

Lead - Similar to chromium and copper, according to 50 FR 30791, the 4 day average concentration in ug/L of lead can not exceed

$$Pb = e^{(1.266[\ln(\text{hardness})] - 4.661)}$$

$$Pb = e^{(1.266[\ln 35] - 4.661)}$$

$$Pb = 0.85\ \mu g/L$$

Manganese - not established

Nickel - Similar to chromium and copper, according to 51 FR 43666, the 4 day average concentration in ug/L of Nickel can not exceed

$$Ni = e^{(0.8460[\ln \text{hardness}] + 1.1645)}$$

$$Ni = e^{(0.8460(\ln 35) + 1.1645)}$$

$$Ni = 65\ \mu g/L$$

APPENDIX E

APPENDIX E

WETLAND EVALUATION TECHNIQUE
SHEPLEY'S HILL LANDFILL AREA

NEW ENGLAND ENVIRONMENTAL, INC.
Environmental Consulting Services

800 Main Street
Amherst, MA 01002
(413) 256-0202
FAX (413) 256-1092

24 November 1993

Mr. John Bleiler
ABB Environmental Services, Inc.
Corporate Place 128
107 Audubon Road
Wakefield, MA 01880

RE: Response to agency comments on WET assessment, Fort Devens, MA.
NEE file #93-1011

Dear Mr. Bleiler:

As requested, New England Environmental, Inc. (NEE) has reviewed the comments relative to the WET assessment of Cold Spring Brook and Plow Shop Ponds on the Fort Devens site. Below, we have listed each comment and our response:

Comment 0-1: "The watersheds, input zones, and service areas for each assessment area need to be described and added to Figure 1. The locality and region used in the analysis also need to be defined".

NEE response: The watershed boundaries for each AA were originally included within Figure 1, although they were not labeled. Figure 1 has been revised so that the watershed boundaries within the figure have been labelled. AA1 has a small watershed, and almost the entire area is shown on Figure 1. However, the watershed for AA2 is very extensive, and covers a large portion of the USGS Ayer and Hudson Quadrangles. Therefore, the entire watershed could not be shown on Figure 1. Attached are photocopies of the USGS maps, which show the entire watershed.

As stated in the WET manual, the input zone "includes the area 300 feet upslope from the AA boundary". Since the AAs are not tributaries, the other variables of the IZ are not used. The IZs were not originally shown on Figure 1 for purposes of clarity; however, they have been added to Figure 1 and are represented by a dashed line around each AA.

The WET manual defines Service Area as "the point to which the service is delivered....The potential exists for any number of service areas to occur downstream of the AA". The watershed of AA1 is less than 20 square miles. Therefore, according to the WET manual, Service Areas within 5 miles

downstream of the AA should be considered. Since the watershed of AA2 is greater than 20 square miles, the WET manual states that service areas within 10 miles downstream should be considered. Thus, it would be unreasonable to detail all Service Areas for each AA.

The Locality and Region were defined in the Site Documentation Form A attached to the report. Locality was defined as the Town of Ayer, while Region was defined as the State of Massachusetts.

Comment 0-2: "The discussion on these pages [4-8] needs to be augmented since the text often does not adequately describe why a particular function or value received a particular rating. For example, on Page 8 paragraph 2, the text provides no explanation as to why the two functions listed received MODERATE ratings".

NEE response: This section has been augmented in order to provide information on the WET value assigned for each function. However, it must be understood that the rating assigned by WET for a particular function is based upon the responses to a wide range of questions. A complete discussion of why a particular function or value received a particular rating is beyond the scope of the report; see the Keys in the *Method for Wetland Functional Assessment* (1983) and the *Wetland Evaluation Technique Literature Review and Evaluation Rationale* (Adamus et al, 1991) for the complete list of questions and responses and their impact upon the WET results.

Comment 0-3: "The HIGH rating for breeding wildlife is questionable for Plow Shop Pond due to poor emergent growth and low vegetation/water interspersion, which would provide relatively poor quality brood-rearing habitat for waterfowl".

NEE response: The High rating referenced (page 8, paragraph 1), is under the Social Significance evaluation of Plow Shop Pond. The Social Significance, or the value of the wetland to society, of this function is determined by WET to be "High" due to the existence of "at least one wildlife species that is on USFWS National Species of Special Emphasis List (Table 1) and is rare or declining in the region". Table 1 lists black duck, a species which is declining in the region and which has been sighted in the AA by NEE biologists.

The poor emergent growth and low vegetation and water interspersion in Plow

Shop Pond are two factors which would reduce the Effectiveness of the area for waterfowl breeding. However, there are a number of other factors which contribute to WET's "High" rating for this function. For example, Plow Shop Pond is located near forested wetlands; these adjacent wetlands of a different type are of high importance as a predictor for breeding (WET literature review). Similarly, the edge of the wetland contains "special habitat features" as defined by WET, such as fruit bearing shrubs (highbush blueberry) and mast-bearing trees (oak); this is also of high importance to this function. Other factors contributing to the "High" rating by WET include the substrate type, low salinity, and the fact that there are preferred food plants within the AA such as *Nymphaea odorata* and *Brasenia schreberi*, which are considered by WET to be preferred food plants for waterfowl.

Comment 0-4: "The assumptions used in the impact evaluation need to be more completely stated. In particular, the text needs to discuss if it is assumed that groundwater will be remediated, if Grove Pond will be concurrently remediated (these two issues relate to recontamination impacts on the wetlands), and if any wetlands restoration procedures (e.g., plantings) were assumed".

NEE response: While groundwater remediation and the clean up of Grove Pond may take place, we have not assumed that this work will be completely effective in eliminating contaminants. Therefore, Question 27, which asks "is there a source that contributes waterborne contaminants (in concentrations hazardous to aquatic life) to the AA?" was answered "yes" for both the AA's and IA's. For most of the other questions, these assumptions, although perhaps important for a qualitative review of the effectiveness of the proposed remediation work, would have no impact on the outcome of the WET evaluation. For example, Question 26, "Nutrient Sources", asks if there is any potential nutrient source, such as a landfill, which is contributing nutrients to the AA. Even with groundwater remediation, there would still be a potential nutrient source, and the answer to this question would still be "yes". Similarly, the WET assessment would be the same with or without restoration plantings, since a three year time period was assumed for the IA assessment, which would allow for the natural re-establishment of vegetation without plantings. As stated in our report: "This time period is arbitrary, and was chosen to represent a sufficient length of time for aquatic bed vegetation to become re-established. If a shorter time period had been chosen, the WET assessment would have yielded more pronounced impacts. Conversely, since many of the impacts from the proposed work will become less

important over time, a WET assessment of the area 5 or 10 years further into the future would have yielded fewer differences between the pre and post development functions and values."

Comment 0-5: "Due to the reduction in vegetation from dredging, it is not clear why functions such as production export are not predicted to be lower than existing (baseline) conditions. Please discuss".

NEE Response: As stated under the response to Question 0-4 above, the IA evaluation was conducted at a point in time three years subsequent to the dredging work, during which time the floating-leaved vegetation would likely have become re-established. If a shorter period of time had been used in the evaluation, then our evaluation would have assumed that the vegetation would not have had sufficient time to become re-established. As a result, the value of the production export function would have been reduced by the WET program.

Comment 0-6: "Grove Pond has significant sediment contamination and would not be a suitable reference wetland for the analysis described. Please modify the text accordingly".

NEE Response: The reference to Grove Pond has been deleted from the text.

Enclosed is a copy of our WET assessment which incorporates the above revisions. Please do not hesitate calling if you have any additional questions or comments.

Sincerely yours,
New England Environmental, Inc.

Ward W. Smith
Wetland Specialist/Soil Scientist

Michael J. Marcus
Senior Biologist
Principal

WWS/if
enc.

NEW ENGLAND ENVIRONMENTAL, INC.

WETLAND EVALUATION TECHNIQUE (WET 2.0)

PLOW SHOP AND COLD SPRING BROOK PONDS FORT DEVENS, AYER, MASSACHUSETTS

Revised 24 November 1993

Prepared For:

ABB Environmental Services, Inc.
Northeast Region
Corporate Place 128
107 Audubon Road
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Prepared By:

New England Environmental, Inc.
800 Main Street
Amherst, MA 01002

NEE File: 93-1011

I. WET 2.0 EVALUATIONS

Introduction to WET

Wetland Evaluation Technique (WET) assessments were conducted on the existing and post-impact conditions in Cold Spring Pond and Plow Shop Pond, which are located on and adjacent to the Fort Devens Military Installation in Ayer, Massachusetts. WET is a standardized evaluation technique for wetlands which yields a rapid assessment of many of the recognized values and functions of a wetland. Functions and values were evaluated in a Level 2 WET assessment, which is generally considered to be a reasonable balance between time, available information, and level of confidence for most situations. WET uses a standardized manual and answer sheet to provide input data for the WET computer program (See Appendix 1). After data are entered into the WET program, a "Low", "Medium", or "High" value is assigned to each function based upon this input.

A combination of eleven functions (i.e., physical, chemical, and biological characteristics) and values (characteristics beneficial to society) are evaluated by the WET program. Each of these functions and values is defined below. These definitions are found in *Wetland Evaluation Technique Literature Review and Evaluation Rationale* (Adamus et al, 1991).

* **Ground Water Recharge** "is the movement of surface water or precipitation into the ground water flow system".

* **Ground Water Discharge** "is the movement (usually laterally or upward) of ground water into surface water".

* **Floodflow Alteration** "is the process by which peak flows from run-off, surface flow, ground water interflow and discharge, and precipitation enter a wetland and are stored or delayed in their downslope journey".

* **Sediment Stabilization** "consists of both shoreline anchoring and dissipation of erosive forces".

* **Sediment/Toxicant Retention** "is the process by which suspended solids and chemical contaminants such as pesticides and heavy metals adsorbed to them are retained and deposited within a wetland".

* **Nutrient Removal/Transformation** "includes the storage of nutrients within the sediment or plant substrate; the transformation of inorganic nutrients to their

organic forms; and the transformation and subsequent removal of one nutrient (nitrogen) as a gas".

* **Production Export** "refers to the flushing of relatively large amounts of organic material (specifically, carbon from net annual primary and secondary productivity) from the wetland to downstream or adjacent deeper waters".

* **Wildlife Diversity/Abundance** "is the support of a notably great on-site diversity and/or abundance of wetland-dependant birds".

* **Aquatic Diversity/Abundance** "is the support of a notably great on-site diversity and/or abundance of fish or invertebrates that are mainly confined to the water and saturated soils".

* **Uniqueness/Heritage** "includes the use of wetlands for aesthetic enjoyment, nature study, education, scientific research, open space, preservation of rare or endemic species, protection of archaeologically or geologically unique features, maintenance of historic sites, and an infinite number of other mostly intangible uses".

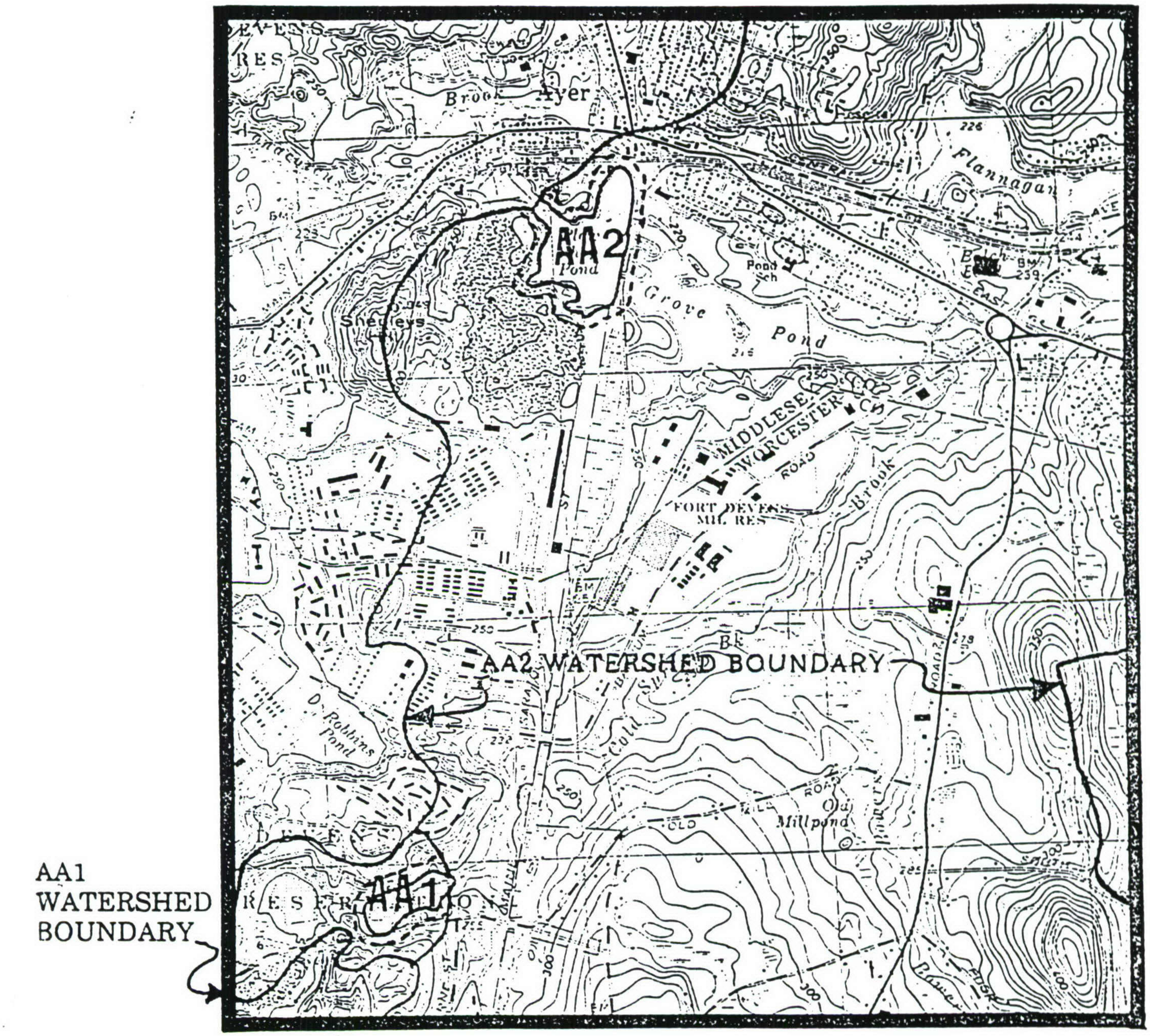
* **Recreation** "includes both consumptive (e.g., sport fishing, food gathering, hunting) and nonconsumptive (e.g., swimming, canoeing, kayaking, birding) forms of recreation that are water dependant and occur in either an incidental or obligatory manner in wetlands".

The above listed functions and values were evaluated by WET in the following contexts: **Social Significance** (the value of the wetland to society); **Effectiveness** (the capability of the wetland to provide the function); and **Opportunity** (the opportunity of the wetland to provide the function).

Using the criteria described in the WET manual, the Assessment Area (AA) for each pond was determined to include not only the ponds, but the surrounding fringe of woody wetland vegetation as well. A WET assessment was conducted based upon the entire AA. A WET evaluation of the probable impacts resulting from removing one foot of sediment from the bottom of each pond was conducted at a point in time three years subsequent to the completion of the work. No detailed plans have yet been formulated for the precise extent of the remediation work. In order to provide a meaningful comparison between the wetlands before and after this work, the boundaries of each Impact Area (IA) were assumed to be

FIGURE 1

NEW ENGLAND ENVIRONMENTAL, INC.



USGS AYER QUADRANGLE
SCALE: 1:25,000

identical to the AA boundary for each pond, although not all of the AA may be altered by the remediation work.

Data for the WET analysis were collected from a number of sources, including the following: site visits by NEE personnel; site reports and documentation provided by ABB, Inc.; previous ecological investigations data by Ecology & Environment, Inc. (June, 1992); the Soil Survey of Middlesex County; FEMA floodplain maps; the USGS Ayer quadrangle; and telephone conversations with the Soil Conservation Service, Natural Heritage and Endangered Species Program, and the National Climactic Data Center. Our evaluation of the WET results is based in part upon the *Wetland Evaluation Technique Literature Review and Evaluation Rationale* (Adamus et al, 1991) and the *Method for Wetland Functional Assessment* (1983).

Cold Spring Brook Pond (AA1)

The first Assessment Area (AA1), Cold Spring Brook Pond, is located to the west of Marne Street (see Figure 1). The boundaries of this AA include the fringe of shrub swamp and wooded swamp which lies to the north of the pond. The western boundary of AA1 is the inlet stream from the upgradient wetland, while the eastern boundary is the culverted outlet beneath Patton Road. The southern limit of this AA is primarily a landfill slope.

Social Significance of AA1

Social Significance is the value of a wetland to society. As shown in Table 1, WET rates the value of Cold Spring Brook Pond to society as "High" for Wildlife Diversity and Abundance as well as Uniqueness and Heritage. The Social Significance of Plow Shop Pond for Wildlife Diversity and Abundance is rated by WET as "High" based upon the existence of black duck, a species that is on the USFWS National Species of Special Emphasis List and is declining in the region. The Social Significance of the Uniqueness and Heritage value is rated as "High" due, in part, to the presence of a long-term monitoring program on the adjacent landfill.

Table 1: Summary of Wet Results for Cold Spring Brook Pond

	Social Significance	Effectiveness	Opportunity
Ground Water Recharge	M	L	*
Ground Water Discharge	M	M	*
Floodflow Alteration	L	M	M
Sediment Stabilization	L	H	*
Sediment/Toxicant Retention	L	H	H
Nutrient Removal/Transformation	L	H	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife D/A Breeding	*	H	*
Wildlife D/A Migration	*	H	*
Wildlife D/A Wintering	*	L	*
Aquatic Diversity/Abundance	L	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High, "M" = Moderate, "L" = Low, "U" = Uncertain, and "*"'s identify conditions where functions and values are not evaluated

The Social Significance of the ground water functions are rated by WET as "Moderate" for this wetland, which is largely due to the downgradient wellfields. The remainder of the evaluated functions are "Low" in Social Significance. The low value of many of these functions is due in part to the small size and watershed of this AA. In addition, the Social Significance of the Floodflow Alteration function is low due to the lack of features of social or economic value within the floodplain to the AA. The Social Significance of the Sediment/Toxicant retention and Nutrient Removal/Transformation functions are low due in part to a lack of surface water drinking supplies or swimming areas downstream. The Social Significance of the Aquatic Diversity/Abundance is Low due to the lack of commercial fishing, recognized fisheries value of the AA, or the lack of any fish species which are on the USFWS National Species of Special Emphasis List. The Social Significance of the Recreation function is Low due to the fact that the AA is not a major public access point to a recreational waterway, nor is it recognized as an area which provides recreational opportunities that are locally deficient. The Social Significance of the Sediment Stabilization function is low because the AA does not act as a buffer to features situated in erosion prone areas.

Effectiveness of AA1

Effectiveness is the capability of a wetland to perform a given function. Using this parameter, WET rates Cold Spring Brook Pond as "High" for Sediment/Toxicant Retention, Nutrient Removal/Transformation, and Wildlife Breeding and Migration. The Effectiveness of the wetland in performing the Sediment/Toxicant Retention and Nutrient Removal/Transformation functions is enhanced by a number of factors including the low water velocity, constricted outlet, and the shallow water depth within this area. The Effectiveness of the wetland to provide the wildlife functions is based upon a number of factors, including the interspersion of openwater and vegetation in the wetland, the diversity of the different vegetation types, the shape of the upland/wetland edge, and the sapric substrates within the wetland. Since this function is relative to waterfowl, the fact that Cold Spring Brook Pond has several aquatic bed species which are important food sources for waterfowl increases the Effectiveness of this wetland for Wildlife Diversity/Abundance Migration.

The Effectiveness of this Assessment Area is rated as "Moderate" for Ground Water Discharge, Floodflow Alteration, and Production Export. The wetland is determined to be moderately effective for Ground Water Discharge due to a number of factors, including the landscape position of the AA. Floodflow Alteration Effectiveness is enhanced by the constricted outlet to the wetland. The Effectiveness of Production Export is a function of factors such as the vegetation classes found in the AA and the relatively large portion of its watershed the wetland occupies.

The Effectiveness of this wetland to provide several functions/values is rated as "Low" by WET. For example, the area will have a low value for wintering waterfowl (Wildlife Diversity/Abundance Wintering) due to the fact that it is a shallow wetland and becomes completely frozen during the winter months. Groundwater Recharge is Low due the wet key functions; since a level 3 assessment was not run, question 60 was not answered "N", and the program assigned a "low" value. If question 60 had been answered "N", the WET program would have yielded an "Uncertain" rating. However, the majority of wetlands in New England are not recharge wetlands. Aquatic Diversity/Abundance is low due to the presence of the adjacent landfill combined with the lack of a perennial outlet, which would tend to trap contaminants within the AA.

Opportunity of AA1

Most of the functions and values are not evaluated for Opportunity in a Level 2 WET Assessment. Of the three functions/values evaluated, the opportunity for Cold Spring Pond to perform the Sediment/Toxicant Retention and Nutrient Removal/Transformation functions is rated as "High" by WET. Cold Spring Pond has the opportunity to provide these functions due to the proximity of the adjacent landfill. Floodflow Alteration is rated as "Moderate" by WET based upon the high percentage of the watershed this wetland occupies. While the watershed is small, which reduces the opportunity for this function, there are relatively few wetlands upgradient of this area, which increases the opportunity for this function.

Plow Shop Pond (AA2)

Plow Shop Pond (AA2) is located downgradient of AA1, and is situated close to the center of Ayer (see Figure 1). The upper limit of this Assessment Area is the culverted inlet from Grove Pond, while the lower limit is the dammed outlet. The AA includes the narrow fringe of scrub-shrub and forested wetland which surrounds the Pond.

Table 2: Summary of Wet Results for Plow Shop Pond

	Social Significance	Effectiveness	Opportunity
Ground Water Recharge	H	U	*
Ground Water Discharge	H	L	*
Floodflow Alteration	L	M	M
Sediment Stabilization	L	M	*
Sediment/Toxicant Retention	M	H	H
Nutrient Removal/Transformation	M	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife D/A Breeding	*	H	*
Wildlife D/A Migration	*	L	*
Wildlife D/A Wintering	*	L	*
Aquatic Diversity/Abundance	L	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High, "M" = Moderate, "L" = Low, "U" = Uncertain, and "*"'s identify conditions where functions and values are not evaluated

Social Significance of AA2

Functions which WET determines to be "High" for the Social Significance of Plow Shop Pond are Ground Water Recharge, Ground Water Discharge, Wildlife Diversity and Abundance, and Uniqueness and Heritage. The significance of Plow Shop Pond for the groundwater functions is due to its proximity to water supply wellfields and the permeable sediments within the area. Like Cold Spring Brook Pond, The Social Significance of Plow Shop Pond for Wildlife Diversity and Abundance is rated by WET as "High" based upon the existence of black duck, a species that is on the USFWS National Species of Special Emphasis List and is declining in the region. The Social Significance of the Uniqueness and Heritage value is rated as "High" due, in part, to the presence of a long-term monitoring program on the adjacent landfill.

The Social Significance of the Sediment/Toxicant Retention and Nutrient Removal/Transformation functions in this wetland are rated as "Moderate" by WET. Both of these ratings are due to the elevated levels of nutrients and other pollutants resulting from the adjacent landfill.

WET rates the Social Significance and Effectiveness of Plow Shop Pond as "Low" for several functions. The Social Significance of the Aquatic Diversity/Abundance is Low due to the lack of commercial fishing, recognized fisheries value of the AA, or the lack of any fish species which are on the USFWS National Species of Special Emphasis List. The Social Significance of the Recreation function is Low due to the fact that the AA is not a major public access point to a recreational waterway, nor is it recognized as an area which provides recreational opportunities that are locally deficient. The Social Significance of the Floodflow Alteration function is low due to the lack of features of social or economic value within the floodplain to the AA. The Social Significance of the Sediment Stabilization function is low because the AA does not act as a buffer to features situated in erosion prone areas.

Effectiveness of AA2

The Effectiveness, or the capability of AA2 to preform a given function, is rated as "High" for Sediment/Toxicant retention and Wildlife Diversity/Abundance Breeding. As with AA1, the Effectiveness of this wetland for Sediment/Toxicant retention is a function of the physical parameters of the Pond including the constricted outlet, low water velocity, and shallow depth. The breeding function

for wildlife, while reduced somewhat by the poor emergent growth and low vegetation and water interspersion in Plow Shop Pond, is raised by a number of other factors which contribute to WET's "High" rating for this function. For example, Plow Shop Pond is located near forested wetlands; these adjacent wetlands of a different type are of high importance as a predictor for breeding (WET literature review). Similarly, the edge of the wetland contains "special habitat features" as defined by WET, such as fruit bearing shrubs (highbush blueberry) and mast-bearing trees (oak); this also is of high importance to this function. Other factors contributing to the "High" rating by WET include the substrate type, low salinity, and the fact that there are preferred food plants within the AA such as *Nymphaea odorata* and *Brasenia schreberi*, which are considered by WET to be preferred food plants for waterfowl.

WET rates the effectiveness of AA2 for Floodflow Alteration, Sediment Stabilization, and Production Export as "Moderate". The moderate rating for Floodflow alteration is based upon such features as the restricted outlet, which allows it to provide for flood storage. However, the AA does not have any of the features which would yield a "High" rating for this function, such as a regulated outlet.

Sediment Stabilization is also rated as "Moderate" due to the lack of features resulting in either a High or Low rating. According to the WET Manual: "Wetlands rated HIGH for this function must be characterized by one of the following characteristics: potential erosive forces present, unsheltered or Zone C greater than Zones A and B, ditches, canals, or levees are present that confine water, high water velocity, evidence of long-term erosion, or a water table influenced by an upstream impoundment. In addition, one of the following characteristics must also be present: rubble substrate, protective of nearby shorelines, greater than 20 ft width of erect vegetation, presence of forest of scrub-shrub, or good water and vegetation interspersion. The only type of wetland considered capable of being rated LOW is one in which there is no flowing water, no boat wakes, no open water wider than 100 ft, and no eroding areas abutting the wetland, as well as having no vegetation (erect or submerged) or rubble."

Like Sediment Stabilization, the "Moderate" rating for Production Export is due to the lack of factors which would result in either a High or Low rating. "To attain a rating of HIGH, the assessment area must have conditions favoring primary productivity...If the wetland system is palustrine the following conditions must be present: significant areas of erect vegetation, potential erosive conditions, Zone B

greater than 10% of AA, potential for expansive flooding, potential for eutrophic conditions or high levels of dissolved solids, high plant productivity, and fringe or island situation. In addition, for all wetland systems, one of the following conditions must not be present: moss-lichen class extensive, sandy substrate, water velocity high or AA unsheltered, low water\vegetation interspersion, presence of direct alteration, artificially manipulated water levels, small watershed, or low levels of suspended solids. To attain a rating of LOW, the AA must have no permanent or intermittent outlets regardless of the levels of productivity present." Since Plow Shop Pond has low interspersion, a "High" rating could not be assigned by WET. Likewise, the permanent inlet and outlet precludes the "Low" rating.

The remainder of the functions and values evaluated by WET are rated as "Low" for Effectiveness. It is interesting to note that WET determines that the Effectiveness of this wetland for the Aquatic Diversity/Abundance function is "Low". As defined previously, this function is "the support of a notably great on-site diversity and/or abundance of fish or invertebrates that are mainly confined to the water and saturated soil". However, although the WET program predicts that this function is "Low" for Plow Shop Pond, our qualitative evaluation is that the Pond is very valuable for this function based upon the abundance of breeding fish. Based upon our on-site visit, we believe that this wetland is very effective at supporting an abundance of warm-water fish species. Ground Water Discharge is rated as low because the wetland has only one of the characteristics that would qualify it as "High" for this function, a relatively stable water level. Nutrient Removal/Transformation rates Low due to the lack of extensive erect vegetation within the wetland. Wildlife Diversity/Abundance Migration and Wintering are rated as "Low" based, in part, upon the fact that Plow Shop Pond is frozen for more than one month during the winter.

Opportunity of AA2

The results for Opportunity for Plow Shop Pond are identical to those for Cold Spring Pond (AA1). As with AA1, most of the functions and values were not evaluated by WET for Opportunity in this Level 2 WET Assessment. The opportunity for Plow Shop Pond to perform the Sediment/Toxicant Retention and Nutrient Removal/Transformation functions is rated as "High" by WET due to the proximity of the adjacent landfill. The opportunity for AA2 to provide for Floodflow Alteration was rated as "Moderate" by WET. This is likely due in part to the relatively large watershed relative to the size of the AA.

Impact Area Evaluations

Both Assessment Areas were evaluated based upon the probable impacts resulting from the removal of one foot of sediment from the bottom of each pond. Each Impact Area was evaluated at a point in time three years subsequent to the completion of this work. This time period is arbitrary, and was chosen by NEE to represent a sufficient length of time for aquatic bed vegetation to become re-established. If a shorter time period had been chosen, the WET assessment would have yielded more pronounced impacts. Conversely, since many of the impacts from the proposed work will become less important with time, a WET assessment of the area 5 or 10 years further into the future would have yielded fewer differences between the pre- and post- development functions and values. Although it can be assumed that groundwater remediation will take place, we did not assume that this work will be completely effective in eliminating contaminants from these wetlands.

WET predicts that the Effectiveness of both IAs will be reduced for the Sediment/Toxicant Retention and Wildlife Diversity/Abundance-Breeding functions, while the Nutrient Removal/Transformation function will be reduced within Cold Spring Brook Pond. The reduction in the Effectiveness of the Sediment/Toxicant Removal function and the Nutrient Removal/Transformation function is due to the alteration of the wetlands. Alterations which destroy vegetation that slows water movement reduces the ability of the wetland to retain sediments. Wetlands which have been excavated are less likely to remove and/or transform nutrients in the water column. In addition, the removal of one foot of sediment will increase the depth of these waterbodies, and deeper wetlands may be less likely to retain sediments and toxicants than shallower wetlands. Finally, the conversion of the substrates within portions of Plow Shop Pond from muck to sand and gravel will reduce the ability of the wetland to trap sediments.

Wildlife Diversity/Abundance-Breeding was determined to be reduced subsequent to the alteration of the area. This is due to the disruption of wetland functions that are important to wildlife following alterations. However, if we had modeled this for longer than 3 years following the alteration, then this would not have had an impact on WET.

Other functions, such as Production Export, were unchanged over the baseline values for the AAs. Production Export is likely unchanged because of the time period used. As previously discussed, the three year time period is likely

Table 3: Summary of Wet Results for Cold Spring Pond, Post-Impact

	Social Significance	Effectiveness	Opportunity
Ground Water Recharge	M	L	*
Ground Water Discharge	M	M	*
Floodflow Alteration	L	M	M
Sediment Stabilization	L	H	*
Sediment/Toxicant Retention	L	L	H
Nutrient Removal/Transformation	L	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife D/A Breeding	*	L	*
Wildlife D/A Migration	*	H	*
Wildlife D/A Wintering	*	L	*
Aquatic Diversity/Abundance	L	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High, "M" = Moderate, "L" = Low, "U" = Uncertain, and "*"'s identify conditions where functions and values are not evaluated

Table 4: Summary of Wet Results for Plow Shop Pond, Post-Impact

	Social Significance	Effectiveness	Opportunity
Ground Water Recharge	H	U	*
Ground Water Discharge	H	L	*
Floodflow Alteration	L	M	M
Sediment Stabilization	L	M	*
Sediment/Toxicant Retention	M	L	H
Nutrient Removal/Transformation	M	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife D/A Breeding	*	L	*
Wildlife D/A Migration	*	L	*
Wildlife D/A Wintering	*	L	*
Aquatic Diversity/Abundance	L	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High, "M" = Moderate, "L" = Low, "U" = Uncertain, and "*"'s identify conditions where functions and values are not evaluated

sufficient to allow floating-leaved vegetation to become re-established. If a shorter period of time had been used in the evaluation, then this function would have shown a decrease over baseline conditions.

WET Summary

A standardized evaluation technique, WET (Wetland Evaluation Technique), was used to conduct assessments on the existing and post-impact conditions in Cold Spring Brook Pond and Plow Shop Pond on the Fort Devens site. The WET analysis determined that the value of both of these wetlands to society is "High" for Wildlife Diversity and Abundance as well as Uniqueness and Heritage. The value of Plow Shop Pond to society is also "High" for Ground Water Recharge and Ground Water Discharge.

WET predicts that the proposed removal of one foot of sediment from the bottom of these ponds will reduce the effectiveness of both wetlands to preform the Sediment/Toxicant Retention and Wildlife Diversity/Abundance-Breeding functions. The Nutrient Removal/Transformation function will be reduced within Cold Spring Brook Pond by the work as predicted by WET.

II. OTHER WETLAND FUNCTIONAL ASSESSMENT METHODS

Hollands and McGee

A Hollands & McGee (H&M) Wetland Functional Assessment (1985) was conducted on Plow Shop Pond and Cold Spring Pond by Ecology and Environment, Inc. as part of their assessment of these wetlands. The Hollands and McGee method was developed by private consulting firms (IEP and Normandeau), and the details of conducting or evaluating this method are generally not available to the public, nor has the complete method been published. The ecological elements in H&M are based largely on the work of Golet & Larson (1974). However, since this method was developed and tested in Massachusetts in 1975, it has the potential for broad applications in the functional assessments of wetlands in this region. The H&M method evaluates 10 wetland functions which incorporate biological, hydrological and socio-cultural interests.

The primary uses of the Hollands and Mcgee method are to compare different wetlands in a region (i.e. a town, county, etc.) so that the relative importance of functional values can be made. This method has been successfully used to evaluate and compare hundreds of wetlands in municipalities in Massachusetts, New Hampshire, and Wisconsin. Although Hollands and McGee (1985) believe that their method compares favorably with more complex methods such as Adamus (1983), which was the precursor to WET 2.0, the two methods have a very different approach. The H&M method relies on expert field personnel which include, at a minimum, a geologist, hydrologist, botanist, and an ecologist to collect site specific detailed data on the wetland(s) being investigated. WET, on the other hand, is designed to be conducted primarily from the office, with minimal field work and non-technical staff. In this respect, the H&M method is similar to the newer Hydrogeomorphic approach which is discussed below.

The H&M wetland evaluation conducted for Cold Spring Brook Pond and Plow Shop Pond provides no regional basis from which to make a decision on the level of the functions found in these wetlands. For instance, the biological model for Plow Shop Pond received a H&M score of 110, while Cold Spring Pond rated 102 for this function. Both were identified as "Moderate" due to a range of scores of this model between 29-158, with a mean of 93. However, practical use of this model indicates that a score of 110 is generally considered "Low" on a regional basis for this part of Massachusetts. Although the H&M system rates these wetlands as "Moderate" in reference to other functional models which require the

output of the biological model, without a comparison of other reference wetlands in the regions, the rating of individual wetland functional values is not appropriate using the H&M method.

Hydrogeomorphic Properties

A recent development in the functional assessment of wetlands is to classify wetlands based on hydrogeomorphic (HGM) properties as is discussed by Brinson et. al (1993, in press). This method is based on a scientific team approach, as in the H&M method, and uses the four following guidelines, or logic train to qualify a function for this method: 1) the function must be clearly defined; 2) it must have recognizable sustaining forces; 3) the function must have hydrologic, geomorphic, or ecologic significance either on the site or off the site; and 4) it must have indicators that can be documented and combined into a functional index that is scaled to reference wetlands.

The HGM method classifies wetlands based on their major properties, such as the geomorphic setting, the sources of water supplying the wetland, and the hydrodynamics of water within the wetland. By first grouping the different wetlands into the HGM classes with similar properties, the functional assessment is defined to address the functions which are linked. This step represents the scientific basis for the presence of the function. The next step is to develop functional profiles for each wetland class. Finally, a scale for expressing functions by using reference wetlands is developed. These reference wetlands are developed for each wetland class in order to serve as the benchmarks for the HGM classes. The reference wetlands are also critical to the setting of goals for compensatory mitigation, and become a standard from which success or failure may be measured. For example, in the H&M wetland functional assessment of both Plow Shop Pond and Cold Spring Brook Pond, no reference was made to the surrounding wetlands, even though there are similar ponds with aquatic beds located in close proximity. A modeled value is of little use if it cannot be compared with either a standard, or a point of reference.

As discussed by the Conservation Foundation (1988), Brinson et al. and Larson and Mazzarese (in press), the general approach which is used to assess the functions of wetlands is to use a generic list of possible wetland functions, and then look for evidence that the wetland being assessed actually performs the functions. As an example, if a given wetland has permanent standing water, is connected to a larger body of water, and has interspersion of both emergent and

submerged vegetation, as in Cold Spring Brook Pond, then it will likely support fish populations, and will thus be determined to have a high probability of aquatic food web support. This general approach has several problems in that a generic series of questions fails to explicitly define the relationship between properties of the wetland and the functions it is supposed to be performing. This "Black Box" approach (Brinson, et al) makes it difficult for the user to understand, learn from, or question the assumed relationships between wetland properties and functions. In fact, these procedures are applied without ever acknowledging the wetland class and its associated attributes.

The HGM approach emphasizes the use of reference wetland populations for the documentation of the relationship between disturbance and function. As such, they are viewed as natural laboratories and as targets for creation and restoration activities. For example, under this approach there is no need to develop complex and detailed design criteria that specify the number of trees to plant, the species composition of the plant community, or the slope and hydroperiod of the wetland surface. Rather, the species composition, cover, density, and other properties of the reference wetlands of a given class can serve as the goals for mitigation. Of importance to any future wetlands mitigation at Fort Devens is that the Discrete use of reference wetland populations in the region of the Base eliminates the need to consider "opportunity" and "effectiveness" as necessary conditions for high rankings of some functions.

<u>**Summary**</u>

Based on our experience using WET 2.0, Hollands and McGee, and other wetland functional assessment methods, it is our opinion that, if restoration of these wetlands is necessary, then the functional assessments of Plow Shop Pond and Cold Spring Brook Pond should also be compared with other regional wetlands which contain similar characteristics. While WET provides a generic functional assessment of the wetlands, a comparison with other reference wetlands of similar classes would provide a necessary ingredient for future mitigation work. Any future remediation success of Plow Shop Pond must be measured against not only the existing conditions of the Pond, but against other non-impacted Ponds in the region.

III. QUALITATIVE WETLAND EVALUATIONS

A. COLD SPRING BROOK POND

Introduction

The area surrounding Cold Spring Brook Pond was examined on June 16, 1993. This pond was formed by the construction of Patton Road and the subsequent blockage of the culverted outlet to the wetland. The pond is essentially a dammed part of Cold Spring Brook, with the dam created by a road culvert that passes under Patton Road. Possible dredge spoils and piled peat material are located around parts of the pond perimeter, and this indicates that the pond may have been dredged in the past. The pond is adjacent to the Cold Spring Brook Landfill site (on the west and south) and a magazine storage area (to the west). Cold Spring Brook Pond was generally evaluated as part of a WET evaluation and as part of a qualitative evaluation for plant communities, wetland types, and ecological structure. The purpose of this section is to present a qualitative wetland evaluation of the existing wetland system.

Plant Communities

Four major plant communities were observed within Cold Spring Pond and its fringe wetland: an Aquatic Bed Plant Community; an Emergent Plant Community; a Shrub/Scrub type; and Forested Swamp. Each of these is described separately below.

Aquatic Bed Plant Community

The majority of the Cold Spring Pond wetland system is occupied by an open water aquatic bed plant community. Although the exact bathometric depths are unknown, much of the pond is relatively shallow, and is able to support rooted aquatic plant life that responds to a two meter phototrophic zone. Sweet water lily (*Nymphaea odorata*), water shield (*Brasenia schreberi*), water marigold (*Megalodonta beckii*), duckweed (*Spirodela* spp.), and coontail (*Ceratophyllum demersum*) were noted in this plant community.

Emergent Plant Community

Much of the shoreline border contains emergent marsh plants, although this band of vegetation is relatively narrow. These plants are generally obligate to facultative wetland plants as rated by the *National List of Plant Species that Occur in Wetlands* (Reed, 1988); these species can easily survive extended periods of saturated soils and flooded conditions. The following plants were observed around the shoreline in the emergent marsh community: tussock sedge (*Carex stricta*), bearded sedge (*Carex comosa*), purple iris (*Iris versicolor*), cattail (*Typha latifolia*), water willow (*Justicia americana*), purple loosestrife (*Lythrum salicaria*), and bugleweed (*Lycopus virginica*).

Shrub/Scrub Plant Community

At the western end of the pond and along parts of the pond perimeter there exists a shrub/scrub wetland plant community. The plant community on the western end is dominated by button bush (*Cephalanthus occidentalis*), smooth alder (*Alnus serrulata*), and silky dogwood (*Cornus amomum*). The understory in this area contains enchanter's nightshade (*Circaea alpina*), sedges (*Carex* spp.), and spotted jewelweed (*Impatiens capensis*). Other perimeter shrub/scrub wetlands are scattered along the perimeter of the pond and contain swamp azalea (*Rhododendron viscosum*), highbush blueberry (*Vaccinium corymbosum*), fetterbush (*Leucothoe racemosa*), winterberry holly (*Ilex verticilatta*), sheep laurel (*Kalmia angustifolia*), maleberry (*Lyonia lingustrina*), and red chokeberry (*Aronia arbutifolia*).

Forested Swamp

There are a few small areas of wetland that are red maple swamps. These areas are located along the fringe of the wetland system and on the peninsula which extends into the pond on its northwestern side. Although red maple (*Acer rubrum*) dominates these areas, gray birch (*Betula populifolia*), silky dogwood (*Cornus amomum*), smooth alder (*Alnus serrulata*), and swamp dewberry (*Rubus hispidus*) are common.

On the southeastern side of this wetland system there is a swamp which is dominated by white pines (*Pinus strobus*) in addition to red maple (*Acer rubrum*). The understory in this area contains american hazelnut, cinnamon fern, and clubmoss.

Wildlife Habitat

Although this report is not intended to provide a detailed habitat evaluation, we will briefly discuss the importance of the evaluated area to wildlife. The open water in Cold Spring Pond provides valuable wildlife habitat for many waterfowl species including black ducks, mallards, wood ducks, great blue heron, green heron, and canada goose. While few of these birds nest here, it is very valuable for forage habitat, providing ample hunting and foraging opportunities. Evidence of breeding black duck was observed within this wetland, and the presence of a wood duck nesting box indicates that this species may be breeding here, or has nested here in the past. The wetland is used by a great variety of reptiles and amphibians including: painted turtle; snapping turtle; bullfrog; pickerel frog, green frog, northern water snake, and others. Mammals likely using the area include muskrat, beaver, raccoon, opossum, and northern water shrew. Although there is no recent beaver activity, signs of past beaver activity exist, particularly in the location of the forested landfill area.

The plant community in the wetland and surrounding upland provides good forage, cover, and escape habitat for wildlife. There are many fruit bearing shrubs and trees, as well as good diversity between strata providing ample nesting, foraging, and breeding habitat for a variety of birds and mammals. The area also has a strong ecotone where forest meets open water. As a general assessment, it is our opinion that this pond, as it presently exists, provides a diverse and valuable wildlife habitat.

The open water area provides potential habitat for a variety of benthic macroinvertebrates and fish. Water quality is the driving force that dictates which species can inhabit this particular environment. The most likely fish that may be found in this pond are golden shiners, yellow bullhead, pumpkinseed, and bluegill. Some evidence of fishing in this pond (bobbers, worm containers, fish-hook packages, etc.) was observed, particularly near the outlet end of the pond.

Observed Impacts

Based upon our field observations, the biology of Cold Spring Brook Pond appears to be at relatively normal levels. However, there is a small pond upgradient of Cold Spring Brook Pond which is heavily discolored with a rust colored substance. The aquatic plant life in this pond is reduced in diversity, abundance, and apparent overall health as compared with the downstream Cold Spring Brook

Pond. The channel draining this small pond contains similar coloration as well as a lack of plant and animal diversity and abundance. The small amount of discoloration in Cold Spring Brook pond is primarily near the inlet from this upgradient channel. No other noticeable plumes or areas of apparently impacted plant and animal life were observed.

Wetland Permits

The wetland Resource Areas around Cold Spring Pond have been previously delineated and surveyed by another consultant. Based on our review of the flagged wetland boundaries, it is our opinion that these flagged boundaries do not accurately depict the wetlands which are jurisdictional under the Massachusetts Wetlands Protection Act (M.G.L. chapter 131, section 40) and Regulations (310 CMR 10.00) or under Section 401 and Section 404 of the Clean Water Act. In general, we found that the flagged wetland boundary underestimated the area of wetlands based both upon vegetative criteria, as specified in the Regulations (310 CMR 10.00) to the Act, as well as the three parameter approach as outlined in the *U.S. Army Corps of Engineers Wetland Delineation Manual* (1987).

Only the Ayer Conservation Commission, or the Massachusetts Department of Environmental Protection on appeal, can make the final determination of the extent of the wetland resource areas which are regulated under state law. Similarly, the extent of wetlands which are subject to federal jurisdiction under Section 404 of the Clean Water Act can be determined only by the U.S. Army Corps of Engineers.

Massachusetts Wetland Protection Act

All wetlands on this site are subject to protection under the Massachusetts Wetlands Protection Act. Under the Regulations to the Act, protectable wetlands are broken down into "Resource Areas". The wetland Resource Areas on site include:

* Land Under Waterway or Waterbody (Cold Spring Brook Pond and the streams)
* Bank (the Banks of the Pond and streams)
* Bordering Vegetated Wetland

No portions of this property are within the 100 year floodplain according to the Flood Insurance Rate Map (Ayer, MA. Panel 3 of 4, 1982). The site does not fall

within the estimated range of state-listed rare wetlands wildlife according to the 1993 Natural Heritage and Endangered Species Program Atlas.

Any work which occurs within 100 feet of the wetland Resource Areas on the site is subject to the jurisdiction of the Ayer Conservation Commission, and will require the filing of either a Request for Determination of Applicability or a Notice of Intent. It is possible that any large-scale remediation project would be approved as a Limited Project under section 10.53(4) in the wetlands regulations.

Federal Wetland Jurisdiction under Section 401 of the Clean Water Act

All projects which propose to alter wetlands require Water Quality Certification under Section 401 of the Federal Clean Water Act before work can proceed. Since October 1, 1992 the D.E.P. regions have been administering the 401 Program and now use the state criteria to determine the boundary of wetlands protectable under 401. If the proposed work will alter in excess of 5,000 square feet of wetlands, then the project will be subject to an alternatives analysis and a more lengthy review process by the D.E.P., and may possibly be denied Certification.

Federal Wetland Jurisdiction under Section 404 of the Clean Water Act

All wetlands on the property are subject to protection under Section 404 of the Clean Water Act. The boundary of wetlands which are protectable under Section 404 is different than that delineated under the Wetlands Protection Act and Section 401 of the Clean Water Act. On this site, it appears that the flagged wetland boundary <u>does not</u> reflect the extent of the wetlands which would be delineated based upon the methodology described in the *U.S. Army Corps of Engineers Wetland Delineation Manual* (1987). This manual describes a multiple parameter methodology which uses the presence of hydric soils, hydrophytic vegetation, and wetland hydrology to establish the boundary of the wetlands. This manual has superseded the more recent *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (1989) for federal wetland boundary delineations.

TABLE 5: PLANT SPECIES FOUND IN WETLANDS, COLD SPRING BROOK POND, FORT DEVENS, AYER, MASSACHUSETTS

COMMON NAME	SCIENTIFIC NAME	INDICATOR STATUS*
Trees		
Red Maple	*Acer rubrum*	FAC
Gray Birch	*Betula populifolia*	FAC
Green Ash	*Fraxinus pennsylvanica*	FACW
Red Pine	*Pinus resinosa*	FACU
White Pine	*Pinus strobus*	FACU
Quaking Aspen	*Populus tremula*	FACU
Black Cherry	*Prunus serotina*	FACU
White Oak	*Quercus alba*	FACU-
Red Oak	*Quercus rubra*	FACU-
American Elm	*Ulmus americana*	FACW-
Shrubs		
Speckled Alder	*Alnus rugosa*	FACW+
Smooth Alder	*Alnus serrulata*	OBL
Red Chokeberry	*Aronia arbutifolia*	FACW
Common Buttonbush	*Cephalanthus occidentalis*	OBL
Silky Dogwood	*Cornus amomum*	FACW
American Hazelnut	*Corylus americana*	FACU-
Witch Hazel	*Hamamelis virginiana*	FAC-
Winterberry Holly	*Ilex verticillata*	FACW+
Sheep Laurel	*Kalmia angustifolia*	FAC
Fetterbush	*Leucothoe racemosa*	FACW
Maleberry	*Lyonia ligustrina*	FACW
Mountain Holly	*Nemopanthus mucronatus*	OBL
Swamp Azalea	*Rhododendron viscosum*	OBL
Willows	*Salix* spp.	FACW
Meadowsweet	*Spirea latifolia*	FAC+
Steeplebush	*Spirea tomentosa*	FACW
Highbush Blueberry	*Vaccinium corymbosum*	FACW-

Lowbush Blueberry	*Vaccinium angustifolium*	FACU-
Wild Raisin	*Viburnum cassinoides*	FACW
Northern Arrowwood	*Viburnum recognitum*	FACW-

Ilianas

Poison Ivy	*Toxicodendron radicans*	FAC
Grape	*Vitis* spp.	FACW-FACU

Ferns

Spinulose Woodfern	*Dryopteris spinulosa*	FAC+
Field Horsetail	*Equisetum arvense*	FAC
Princess Pine Clubmoss	*Lycopodium obscurum*	FACU
Sensitive Fern	*Onoclea sensibilis*	FACW
Cinnamon Fern	*Osmunda cinnamomea*	FACW
Interrupted Fern	*Osmunda claytoniana*	FAC
Royal Fern	*Osmunda regalis*	OBL
Bracken Fern	*Pteridium aquilinum*	FACU
New York Fern	*Thelypteris noveboracensis*	FAC
Marsh Fern	*Thelypteris thelypteroides*	FACW+

Forbs

Jack-In-The-Pulpit	*Arisaema triphyllum*	FACW-
Swamp Milkweed	*Asclepias incarnata*	OBL
Aster	*Aster* spp.	
Spotted Wintergreen	*Chimaphila maculata*	UPL
Goldthread	*Coptis trifolia*	FACW
Spotted Joe-Pye-Weed	*Eupatoriadelphus maculatus*	FACW
Boneset	*Eupatorium perfoliatum*	FACW+
Bedstraw	*Galium* spp.	
Hawkweeds	*Hieracium* spp.	UPL
Bluets	*Houstonia* spp.	FAC-FACU
Spotted Jewelweed	*Impatiens capensis*	FACW
Yellow Iris	*Iris pseudoacorus*	OBL
Blueflag Iris	*Iris versicolor*	OBL

Duckweed	*Lemna* spp.	OBL
Bugleweed	*Lycopus virginicus*	OBL
Purple Loosestrife	*Lythrum salicaria*	FACW+
Canada Maylower	*Maianthemum canadense*	FAC-
Water-Millfoil	*Myriophyllum* spp.	OBL
Water Lily	*Nuphar* spp.	OBL
Pale Smartweed	*Polygonum lapathifolium*	FACW+
Pickerelweed	*Pontederia cordata*	OBL
Pondweed	*Potamogeton* spp.	OBL
Swamp Buttercup	*Ranunculus septentrionalis*	OBL
Blackberry	*Rubus* spp.	
Dewberry	*Rubus hispidus*	FACW
Curled Dock	*Rumex crispus*	FACU
Arrowhead	*Saggitaria latifolia*	OBL
Tall Goldenrod	*Solidago altissima*	FACU-
Rough Goldenrod	*Solidago rugosa*	FAC
Skunk Cabbage	*Symplocarpus foetidus*	OBL
Common Cattail	*Typha latifolia*	OBL
Violet	*Viola* spp.	FACW-OBL

Grasses and Grasslike Species

Fringed Sedge	*Carex crinita*	OBL
Broom Sedge	*Carex scoparia*	FACW
Tussock Sedge	*Carex stricta*	OBL
Blunt Broom Sedge	*Carex tribuloides*	FACW+
Other Sedges	*Carex* spp.	FACW-OBL
Spike-Rush	*Eleocharis* spp.	FACW+-OBL
Other Grasses	*Graminaceae*	
Canada Rush	*Juncus canadensis*	OBL
Soft Rush	*Juncus effusus*	FACW+
Rice Cut-Grass	*Leersia oryzoides*	OBL
Haircap Moss	*Polytrichum commune*	FACU**
Sphagnum Moss	*Sphagnum* spp.	OBL**

Category	Symbol	Definition
OBLIGATE HYDROPHYTE	OBL	Nearly always occurs in wetlands (>99%)
FACULTATIVE WETLAND	FACW	Usually occurs in wetlands (67% to 99%)
FACULTATIVE	FAC	Commonly occurs in both wetlands and uplands (34% to 66% in wetlands)
FACULTATIVE UPLAND	FACU	Usually occurs in uplands, but may occasionally occur in wetlands (1% to 33%)
UPLAND	UPL	Nearly always occurs in uplands (<1% in wetlands)

A positive (+) sign behind the Facultative Indicator categories indicates a frequency toward the higher end of the category (more frequently found in wetlands), while a negative (-) sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

D = Dominant (> 50% cover)
C = Common (11%-49% cover)
O = Occasional (1%-10% cover)

* 1988 Wetland Plant List, Northeast Region. National Wetlands Inventory, U.S. Fish and Wildlife Service.

** Indicator status for mosses assigned by experience of NEE personnel; mosses are not rated by Wetland Plant List (1988).

PLOW SHOP POND

Introduction

The Plow Shop Pond wetlands were examined on June 16, 1993 by New England Environmental, Inc. (NEE) biologists. This pond and the adjacent wetlands are located in the northeast corner of the Main Post at Fort Devens, adjacent to the Shepley's Hill Landfill. The pond receives water from Grove Pond and a relatively large upgradient watershed. The Pond drains into Nonacoicus Brook, which eventually discharges into the Nashua River. Plow Shop Pond is an impounded area, with the primary outlet feeding Nonacoicus Brook. Plow Shop Pond is approximately 30 acres in size. This area and the associated wetlands were evaluated by New England Environmental, Inc. as part of a WET evaluation of wetland functional values, and as part of a qualitative evaluation for plant communities, wetland types, and ecological regime. The purpose of this section is to present a qualitative evaluation of the existing wetland system.

Plant Communities

Four major plant communities were observed within Plow Shop Pond and its fringe wetland, although the vast majority of the system is Aquatic Bed. The Emergent Plant Community, Shrub/Scrub type, and Forested Swamp are found in a narrow band which surrounds the Pond. Each of these plant communities is described separately below.

Aquatic Bed Plant Community

The majority of this wetland system is an open water aquatic bed plant community. Much of the area is less than 6.6 feet deep, which helps to describe it as shallow and capable of supporting a dense rooted vascular plant community. Sweet water lily (*Nymphaea odorata*), water shield (*Brasenia schreberi*), duckweed (*Spirodela spp.*), coontail (*Ceratophyllum demersum*), milfoil (*Myriophyllum spp.*), northern arrowhead (*Sagittaria cuneata*), and pickerelweed (*Pontedaria cordata*) were all noted in this community and comprise 80-90% of the plant species present.

Emergent Plant Community

Emergent marsh plants were noted along the majority of the shoreline border. These plants are generally obligate wetland species, with some facultative wetland plant species also present. The following species were noted along the shoreline as part of the emergent plant community: tussock sedge (*Carex stricta*), bugleweed (*Lycopus virginica*), bearded sedge (*Carex comosa*), purple iris (*Iris versicolor*), broadleaf cattail (*Typha latifolia*), yellow iris (*Iris pseudacorus*), eastern burreed (*Sparganium americanum*), soft-stemmed bullrush (*Scirpus validus*), water smartweed (*Polygonum punctatum*), purple loosestrife (*Lythrum salicaria*), and lurid sedge (*Carex lurida*).

Shrub/Scrub Wetland Plant Community

The majority of the wetland fringe around Plow Shop Pond contains a shrub/scrub wetland plant community. This plant community is found in association with many small red maple (*Acer rubrum*) saplings. The shrub/scrub plant community contains the following species: smooth alder (*Alnus serrulata*), speckled alder (*Alnus rugosa*), highbush blueberry (*Vaccinium corymbosum*), maleberry (*Lyonia lingustrina*), swamp azalea (*Rhododendron viscosum*), northern arrow-wood (*Viburnum recognitum*), wild raisin (*Viburnum cassanoides*), mountain holly (*Nemopanthus mucronta*), sheep laurel (*Kalmia angustifolia*), silky dogwood (*Cornus amomum*), ironwood (*Carpinius caroliniana*), witch-hazel (*Hammamelis virginiana*), and winterberry holly (*Ilex verticilata*). The understory of this narrow fringe community contained many species including spotted jewelweed (*Impatiens capensis*), marsh fern (*Thelypteris thelypteroides*), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnomomea*), skunk cabbage (*Symplocarpus foetidus*), peat moss (*Sphagnum spp.*), haircap moss (*Polytrichum commune*), staghorn clubmoss (*Lycopodium clavatum*), virginia creeper (*Parthenocissus quinquefolia*), and poison ivy (*Toxicondendron radicans*).

Forested Swamp Community

In an area adjacent near the pond outlet (Nonacoicus Brook), there is a red maple swamp forested wetland. The overstory is dominated by red maple and gray birch (*Betula populifolia*), and silver maple (*Acer saccharinum*). In the shrub layer wild raisin, nannyberry (*Viburnum lentago*), and highbush blueberry are found. The understory is dominated by cinnamon fern, marsh fern, jewelweed, and joe-pye weed (*Eupatorium maculatum*).

Wildlife Habitat

Although it is beyond the scope of this report to provide a detailed wildlife habitat evaluation of Plow Shop Pond, we are providing a general discussion of the more important wildlife habitats which were evaluated in this study. The approximately 30 acres of open water found in Plow Shop Pond presently provides excellent brood-rearing and migratory feeding habitat for many waterfowl species including black duck, mallard, wood duck, great blue heron, green-backed heron, and canada goose. Although there are suitable nesting areas for waterfowl adjacent to the Pond, we did not observe any waterfowl broods during our one day site visit. The pond area has large areas of aquatic vegetation for forage and brood-rearing by many species of dabbling ducks and geese, and is likely to be heavily used by migrating waterfowl. There is little habitat interspersion or cover within the main body of the pond, which reduces somewhat the habitat value for several waterfowl species (i.e. wood duck), although the several wooded coves and outlet wetland provide additional habitat interspersion.

The Plow Shop Pond wetland system is used by a variety of reptiles and amphibians which were observed within the area including: painted turtle; snapping turtle; northern water snake; bullfrog; and green frog. Although several species of salamanders are likely to occur within this wetland complex, none were observed during our site visit. Mammals observed or which are likely using the area are muskrat, beaver, raccoon, opossum, and northern water shrew. There is some recent sign of beaver activity along the southern edge of the pond, and muskrat were observed in several of the small coves. Raccoon tracks were observed within the wetlands.

The plant community in the wetland and surrounding upland provides good shade, forage, cover, and escape habitat. There are a diverse variety of fruit and mast bearing shrubs and trees (ie. highbush blueberry, red oak), and a good interspersion of plant strata providing nesting, foraging, and breeding habitat for many different bird and mammal species. A very large and important ecotone exists where open water meets forest and shrub areas. As a general assessment, it is our opinion that Plow Shop Pond and the adjacent wetlands presently provides good wildlife habitat for a diverse group of fish and animal species.

The open water area of Plow Shop Pond provides potential habitat for a variety of benthic macroinvertebrates and warm water fish. Water quality is the primary ingredient in determining which species inhabit this environment. The most

likely fish that may be found in this pond, and those which we observed are: golden shiners; yellow bullhead; pumpkinseed; bluegill; large mouth bass; and chain pickerel. Ample evidence exists of fishing in the area (rod-holders, bait cans, trash, bobbers, etc.). There are presently posted warning signs which indicate that Plow Shop Pond is a catch and release area only.

Our site inspection was impressed by the large numbers of nesting bluegills found around almost the entire perimeter of the pond in shallow gravelly substrates. Equally impressive were the large number and the great size of large mouth bass which were observed near the inlet, the outlet, and throughout the aquatic bed.

Observed Impacts

Shepley's Hill Landfill is situated to an area south and adjacent to Plow Shop Pond. Two coves extend from the main body of the Pond towards the landfill, and these coves contain a red precipitate. This precipitate was not observed in any other areas of the Pond. In the northern cove, a steady plume of groundwater was observed to be discharging into the area.

There was a marked contrast of the plant communities within these two coves as compared to the greater body of water of Plow Shop Pond, with a general lack of plant diversity, especially in the northern cove. In addition, several dead trees (white pine and red maples) were observed adjacent to the northern cove. No other obvious tree diebacks were observed around the entire perimeter of Plowshop Pond. The aquatic plant life in the northern cove was sparse and unhealthy in appearance in comparison with the rest of the pond, and much of the aquatic vegetation had absorbed the rust-colored precipitate. Almost all of the pond bottom in the northern cove was rust-colored. Several nesting bluegills were observed within the northern cove.

At the southern cove, similar observations were made, although the observed impacts were less pronounced. At this cove, there was no observed plume of water entering the area, and there was less discoloration. The area did appear to contain a lack of diversity in aquatic plant species. No fish were observed in the southern cove.

Wetland Permits

The wetland Resource Areas around Plow Shop Pond have been previously

delineated and surveyed by another consultant. New England Environmental, Inc. generally agrees with the boundaries as established by the flags in the field, however; only the Ayer Conservation Commission, or the Massachusetts Department of Environmental Protection on appeal, can make the final determination of the extent of the wetlands which are regulated under state law. Similarly, the extent of wetlands which are subject to federal jurisdiction under Section 404 of the Clean Water Act can be determined only by the U.S. Army Corps of Engineers.

Massachusetts Wetlands Protection Act

All wetlands on this site are subject to protection under the Massachusetts Wetlands protection Act. Under the Regulations of the Act, protectable wetlands are broken down into "Resource Areas". According to the Flood Insurance Rate Map (Ayer, MA., Panel 3 of 4), there is a significant area surrounding Plow Shop Pond which is subject to flooding in the 100 year storm event. This area of flooding extends to adjacent areas down stream. The wetland Resource Areas on the site include:

* Land Under a Waterway and Waterbody (Plow Shop Pond and inlet/outlet)
* Bank (the Banks of the Pond and streams)
* Bordering Vegetated Wetland
* Bordering Land Subject to Flooding (100 year floodplain)

The site does not fall within the estimated range of state-listed rare wetlands wildlife according to the 1993 Natural Heritage and Endangered Species Program Atlas.

A wetland filing with the Ayer Conservation Commission will be required for any proposed remediation work. It is likely that any large-scale remediation project can be approved as a Limited Project under section 10.53(4) or perhaps other appropriate sections in the wetlands regulations.

Federal Wetland Jurisdiction under Section 401 of the Clean Water Act

All projects which propose to alter wetlands require Water Quality Certification under Section 401 of the Federal Clean Water Act before work can proceed. Since October 1, 1992 the D.E.P. regions have been administering the 401 Program and now use the state criteria to determine the boundary of wetlands protectable

under 401. If the proposed work will alter in excess of 5,000 square feet of wetlands, then the project will be subject to an alternatives analysis and a more lengthy review process by the D.E.P., and may possibly be denied Certification.

Federal Wetland Jurisdiction under Section 404 of the Clean Water Act

All wetlands on the property are subject to protection under Section 404 of the Clean Water Act. The boundary of wetlands which are protectable under Section 404 is different than that delineated under the Wetlands Protection Act and Section 401 of the Clean Water Act. On this site, it appears that the flagged wetland boundary generally coincides with the line which would have been delineated based solely upon the methodology described in the *U.S. Army Corps of Engineers Wetland Delineation Manual* (1987). This manual describes a multiple parameter methodology which uses the presence of hydric soils, hydrophytic vegetation, and wetland hydrology to establish the boundary of the wetlands. This manual has superseded the more recent *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (1989) for federal wetland boundary delineations.

TABLE 5: PLANT SPECIES FOUND IN PLOW SHOP POND WETLANDS.

COMMON NAME	SCIENTIFIC NAME	INDICATOR STATUS*
Trees		
Red Maple	*Acer rubrum*	FAC
Silver Maple	*Acer saccharinum*	FACW
Gray Birch	*Betula populifolia*	FAC
Ironwood	*Carpinus caroliniana*	FAC
Red Pine	*Pinus resinosa*	FACU
White Oak	*Quercus alba*	FACU-
Red Oak	*Quercus rubra*	FACU-
American Elm	*Ulmus americana*	FACW-
Shrubs		
Speckled Alder	*Alnus rugosa*	FACW+
Smooth Alder	*Alnus serrulata*	OBL
Common Buttonbush	*Cephalanthus occidentalis*	OBL
Silky Dogwood	*Cornus amomum*	FACW
American Hazelnut	*Corylus americana*	FACU-
Black Huckleberry	*Gaylussacia baccata*	FACU
Witch Hazel	*Hamamelis virginiana*	FAC-
Sheep Laurel	*Kalmia angustifolia*	FAC
Maleberry	*Lyonia ligustrina*	FACW
Sweetgale	*Myrica gale*	OBL
Mountain Holly	*Nemopanthus mucronatus*	OBL
Pink Azalea	*Rhododendron nudiflorum*	FAC
Swamp Azalea	*Rhododendron viscosum*	OBL
Staghorn Sumac	*Rhus typhina*	UPL
Willows	*Salix* spp.	FACW
American Elderberry	*Sambucus canadensis*	FACW-
Meadowsweet	*Spirea latifolia*	FAC+
Steeplebush	*Spirea tomentosa*	FACW
Highbush Blueberry	*Vaccinium corymbosum*	FACW-
Wild Raisin	*Viburnum cassinoides*	FACW

Nannyberry	*Viburnum lentago*	FAC
Northern Arrowwood	*Viburnum recognitum*	FACW-

Ilianas

Virginia Creeper	*Parthenocissus quinquefolia*	FACU
Poison Ivy	*Toxicodendron radicans*	FAC

Ferns

Lady Fern	*Athyrium Filix-femina*	FAC
Spinulose Woodfern	*Dryopteris spinulosa*	FAC+
Staghorn Clubmoss	*Lycopodium clavatum*	FAC
Sensitive Fern	*Onoclea sensibilis*	FACW
Cinnamon Fern	*Osmunda cinnamomea*	FACW
Royal Fern	*Osmunda regalis*	OBL
Bracken Fern	*Pteridium aquilinum*	FACU
New York Fern	*Thelypteris noveboracensis*	FAC

Forbs

Ground Nut	*Apios americana*	FACW
Jack-In-The-Pulpit	*Arisaema triphyllum*	FACW-
Aster	*Aster* spp.	
Bog Hemp	*Boehmeria cylindrica*	FACW+
Water Shield	*Brasenia schreberi*	OBL
Coontail	*Ceratophyllum demersum*	OBL
Goldthread	*Coptis trifolia*	FACW
Spotted Joe-Pye-Weed	*Eupatoriadelphus maculatus*	FACW
Strawberry	*Fragaria virginiana*	FACU
Bedstraw	*Galium* spp.	
Hawkweeds	*Hieracium* spp.	UPL
Bluets	*Houstonia* spp.	FAC-FACU
Spotted Jewelweed	*Impatiens capensis*	FACW
Yellow Iris	*Iris pseudoacorus*	OBL
Blueflag Iris	*Iris versicolor*	OBL
Bugleweed	*Lycopus virginicus*	OBL
Yellow Loosestrife	*Lysimachia terrestris*	OBL
Purple Loosestrife	*Lythrum salicaria*	FACW+

Canada Maylower	*Maianthemum canadense*	FAC-
Water Marigold	*Megalodonta beckii*	OBL
Forget-me-not	*Myosotis scorpioides*	OBL
Water-Millfoil	*Myriophyllum* spp.	OBL
Sweet Water Lily	*Nymphaea odorata*	OBL
Pale Smartweed	*Polygonum lapathifolium*	FACW+
Pickerelweed	*Pontederia cordata*	OBL
Pondweed	*Potamogeton* spp.	OBL
Common Cinquefoil	*Potentilla simplex*	FACU-
Buttercup	*Ranunculus spp.*	FAC-OBL
Blackberry	*Rubus* spp.	
Dewberry	*Rubus hispidus*	FACW
Raspberry	*Rubus* spp.	
Arrowhead	*Saggitaria latifolia*	OBL
Rough Goldenrod	*Solidago rugosa*	FAC
Goldenrod	*Solidago* spp.	
Skunk Cabbage	*Symplocarpus foetidus*	OBL
Common Cattail	*Typha latifolia*	OBL

Mosses and Grass-like Plants

Blue Joint Grass	*Calamagrostis canadensis*	FACW+
Fringed Sedge	*Carex crinita*	OBL
Lurid Sedge	*Carex lurida*	OBL
Broom Sedge	*Carex scoparia*	FACW
Stalk-Grain Sedge	*Carex stipata*	OBL
Tussock Sedge	*Carex stricta*	OBL
Blunt Broom Sedge	*Carex tribuloides*	FACW+
Other Sedges	*Carex* spp.	FACW-OBL
Other Grasses	*Graminaceae*	
Timothy	*Phleum pratense*	FACU
Flat Bluegrass	*Poa compressa*	
Haircap Moss	*Polytrichum commune*	FACU**
Softstem Bulrush	*Scirpus validus*	OBL
Bur Reed	*Sparganium* spp.	OBL
Sphagnum Moss	*Sphagnum* spp.	OBL**

Category	Symbol	Definition
OBLIGATE HYDROPHYTE	OBL	Nearly always occurs in wetlands (>99%)
FACULTATIVE WETLAND	FACW	Usually occurs in wetlands (67% to 99%)
FACULTATIVE	FAC	Commonly occurs in both wetlands and uplands (34% to 66% in wetlands)
FACULTATIVE UPLAND	FACU	Usually occurs in uplands, but may occasionally occur in wetlands (1% to 33%)
UPLAND	UPL	Nearly always occurs in uplands (<1% in wetlands)

A positive (+) sign behind the Facultative Indicator categories indicates a frequency toward the higher end of the category (more frequently found in wetlands), while a negative (-) sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

D = Dominant (> 50% cover)
C = Common (11%-49% cover)
O = Occasional (1%-10% cover)

* 1988 Wetland Plant List, Northeast Region. National Wetlands Inventory, U.S. Fish and Wildlife Service.

** Indicator status for mosses assigned by experience of NEE personnel; mosses are not rated by Wetland Plant List (1988).

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APPENDIX E

WET DATA FORMS

WET - COLDSPRIN

FORM A: SITE DOCUMENTATION (Page 1 of 2)

Part 1 - Background Information AA1

Evaluation Site: COLD SPRING POND Date: 6-18-93

Site Location (Section, Range, and Township): AYER

Has the evaluator taken a training course in WET Version 2.0? Yes

Agencies/Experts Contacted: SCS, NOAA, MA F+W, NAT. HERITAGE

Circle the assessment levels to be completed? SS-1 SS-2 E/O-1&2 E/O-3 HS

Is the wetland tidal or nontidal? If the wetland is nontidal, indicate the month(s) that represent wet, dry, and average conditions, or if only average annual condition will be used, give rationale. Also, indicate if the previous 12 months of precipitation has been above, below, or near normal.

Nontidal. Wet Cond. - [illegible] - March, veg - [illegible]; Dry Cond. [illegible] - Hydrology - Aug. Veg - [illegible] Ave. Cond - [illegible] - June veg - Sept.

Is this evaluation an estimate of past conditions or a prediction of future conditions? (If answer is yes, explain nature and source of predictive data.)

NO

Will alternative ratings be used to evaluate any of the functions or values (if yes, explain)? NO

Part 2 - Identification and Delineation of Evaluation Areas

Sketch a map on the following page, or attach a suitable map (photocopy of topgraphic map) that shows the following information: See Figure 1

- -- Boundaries of the AA, IA, and IZ, and the location of service areas.
- -- Watershed boundaries of AA, and service areas.
- -- Extent of surface water in the AA during the wet and dry seasons.
- -- Open water (channels and pools) within and adjacent to the AA.
- -- Normal direction of channel or tidal flow
- -- Normal direction of wind-driven waves or current.
- -- Impact area(s).
- -- Scale of distance and north compass direction.

Explain the procedures used to identify or delineate the AA, IA, IZ, service areas, and the watersheds of these areas if they differed from the guidelines outlined in Section 2.7. N/A

-- Continued --

FORM A: SITE DOCUMENTATION (Page 2 of 2)

Part 2 (Cont.)

Estimate the extent of the following areas:

Assessment Area = ±3 acres
Impact Area = N/A acres (only if applicable)
Watershed of AA = ±50 acres/ 0.08 miles^2 (acres x 0.0016 = miles)
Wetlands in AA = ±3 acres
Wetlands in the watershed of closest service area = 7500 acres
Wetlands and deepwater in the watershed of closest service area = 7500 acres

How were locality and region defined for this evaluation?
Locality – Town (Ayer)
Region – State (Massachusetts)

Sketch of Evaluation Areas (or attach map):

See Figure 1

FORM B: EVALUATION ANSWER SHEET

Evaluation Site: Cold Spring Pond AA-1

SOCIAL SIGNIFICANCE EVALUATION - LEVEL 1

3.1.1 "Red Flags"

				Comments/Assumptions
s1.	Y	N	U	NOT LISTED BY MA. NAT. HERITAGE
s2.	Y	N	U	
s3.	Y	N	U	
s4.	Y	N	U	
s5.	Y	N	U	
s6.	Y	N	U	

3.1.2 On-site Social Significance

					Comments/Assumptions
s7.	Y	N	U	I	
s8.	Y	N	U	I	SUPERFUND SITE

3.1.3 Off-site Social Significance

					Comments
s9.	Y	N	U	I	
s10.	Y	N	U		
s11.	Y	N	U		
s12.	Y	N	U		
s13.	Y	N	U		
s14.	Y	N	U		
s15.	Y	N	U	I	ESTIMATED HABITAT MAP
s16.	Y	N	U	I	GROVE POND WELL FIELD
s17.	Y	N	U	I	
s18.	Y	N	U	I	
s19.	Y	N	U		
s20.	Y	N	U		NO IMPORTANT FISH

					Comments
s21.	Y	N	U		BLACK DUCK/WOOD DUCK
s22.	Y	N	U	I	
s23.	Y	N	U		
s24.	Y	N	U		
s25.	Y	N	U		SUPERFUND SITE
s26.	Y	N	U		
s27.	Y	N	U		NO LOCAL [illegible]
s28.	Y	N	U		
s29.	Y	N	U		[illegible]
s30.	Y	N	U		
s31.	Y	N	U		[illegible]

SOCIAL SIGNIFICANCE EVALUATION - LEVEL 2

Context Region (Circle one)

- Standard Density Circle
- Locality
- Hydrologic Unit

Question #

			Comments/Assumptions
1	Y	N	[illegible]
2	Y	N	[illegible]
3	Y	N	[illegible] FLOOD [illegible]
4	Y	N	FLOOD [illegible]

Evaluation Site: COLD [illegible]

EFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 1 (OFFICE)

Q.#	$\overline{X}$	W	D	COMMENTS/ASSUMPTIONS
1.1	Y N			
1.2	Y N			- ECO [illegible] SCS
1.3	Y N			
2.1.1	Y N			
2.1.2	Y N			
2.1.3	Y N			
2.2.1	Y N I			
2.2.2	Y N I			[illegible] FIELD OBS [illegible]
3.1	Y N			
3.2	Y N			NWI MAPS
3.3	Y N			NWI MAPS
4.1	Y N			- NASHUA/MERRIMACK RIVER
4.2A	Y N			- USGS
4.2B	Y N			
4.2C	Y N			
4.2D	Y N			
5.1.1		Y N		
5.1.2		Y N		
5.2		Y N		
6.1	Y N			USGS
6.2	Y N			FIELD INVESTIGATION
7	Y N I			
8.1	Y N			- FIELD OBS
8.2	Y N			
8.3	Y N			- USGS & FIELD
8.4	Y N			
9.1		Y N		- CONSTRICTED OUTLET
9.2		Y N I		
9.3		Y N I		- GNDWATER DIS.
10A	Y N			- AQUATIC BED
10B	Y N			
10C	Y N			
10D	Y N			
10E	Y N			
10F	Y N			

FORM B (Cont.)

Evaluation Site: COLD SPRING - AA 1

WETLAND CONDITION

Q.#	$\bar{X}$	W	D
11	Y N	Y N	Y N
12A	Y N	Y N	Y N
12Aa	Y N	Y N	Y N
12Ab	Y N	Y N	Y N
12Ac	Y N	Y N	Y N
12Ad	Y N	Y N	Y N
12Ae	Y N	Y N	Y N
12B	Y N	Y N	Y N
12Ba	Y N	Y N	Y N
12Bb	Y N	Y N	Y N
12Bc	Y N	Y N	Y N
12Bd	Y N	Y N	Y N
12Be	Y N	Y N	Y N
12C	Y N	Y N	Y N
12Ca	Y N	Y N	Y N
12Cb	Y N	Y N	Y N
12Cc	Y N	Y N	Y N
12Cd	Y N	Y N	Y N
12D	Y N	Y N	Y N
12Da	Y N	Y N	Y N
12Db	Y N	Y N	Y N
12E	Y N	Y N	Y N
13A	Y N	Y N	Y N
13Aa	Y N	Y N	Y N
13Ab	Y N	Y N	Y N
13Ac	Y N	Y N	Y N
13Ad	Y N	Y N	Y N
13Ae	Y N	Y N	Y N
13B	Y N	Y N	Y N
13Ba	Y N	Y N	Y N
13Bb	Y N	Y N	Y N
13Bc	Y N	Y N	Y N
13Bd	Y N	Y N	Y N
13Be	Y N	Y N	Y N
13C	Y N	Y N	Y N
13Ca	Y N	Y N	Y N
13Cb	Y N	Y N	Y N
13Cc	Y N	Y N	Y N
13Cd	Y N	Y N	Y N
13D	Y N	Y N	Y N
13Da	Y N	Y N	Y N
13Db	Y N	Y N	Y N
13E	Y N	Y N	Y N

COMMENTS/ASSUMPTIONS

DOMINANT A - AQUATIC BED, ROOTED VASCULAR

EDGE B - SHRUB/SCRUB BROAD LEAF DECIDUOUS

C - AQUATIC BED, ROOTED VASCULAR

>10% - AQUATIC BE

>10% - FORESTED F

>10% - SHRUB/SCRUB

FORM B (Cont.)

Evaluation Site: COLD SPRING POND - AA 1

Q.#	$\bar{X}$	W	D	COMMENTS/ASSUMPTIONS
14.1	Y N	Y N	Y N	FIELD OBSERV.
14.2	Y N	Y N	Y N	
15.1A	Y N I			
15.1B	Y N I	FIELD OBSERV.		
15.1C	Y N I			
15.2	Y N I	NO CHANNEL FLOW		
16A	Y N	Y N	Y N	FIELD OBSERV.
16B	Y N	Y N	Y N	
16C	Y N	Y N	Y N	
17	Y N	< 70% ANY CLASS		
18	Y N I			
19.1A	Y N I - TREES, TOPO			
19.1B	Y N I			
19.2	Y N I			
19.3	Y N I			
20.1	Y N I			
20.2	Y N I			
21A	Y N - MOSTLY FORESTED ALTHOUGH SIG. LANDFILL AREA			
21B	Y N			
21C	Y N			
21D	Y N			
21E	Y N			
22.1.1	Y N			
22.1.2	Y N I			
22.2	Y N			
22.3	Y N I			
23	Y N CONSTRICTING CULVERTS			
24.1	Y N I - SCS SOILS MAP			
24.2	Y N I			
24.3	Y N I			
24.4	Y N I			
24.5	Y N			
25.1	Y N - LANDFILL			
25.2A	Y N I			
25.2B	Y N I			
25.3	Y N - UNSTABLE SOILS			

FORM B (Cont.)

Evaluation Site: COLD SPRING POND AA1

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	X̄	W	D	Comments
26.1	Y N			LANDFILL
26.2	Y N I			GRNDWTR DISCH.
26.3	Y N I			CHANNEL FROM UPGRADIENT AA
27.1	Y N			LANDFILL
27.2	Y N I			
27.3	Y N I			CHANNEL FROM UPGRADIENT AA

EFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 2 (FIELD)

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	X̄	W	D	Comments
28	Y N			
29.1	Y N			SHRUBS ON AA [illegible]
29.2	Y N			7%
30.	Y N	Y N	Y N	
31.1	Y N	Y N	Y N	
31.2	Y N	Y N	Y N	
31.3	Y N	Y N	Y N	
31.4	Y N I	Y N I	Y N I	WINTER [illegible]
31.5	Y N	Y N	Y N	
31.6A	Y N	Y N	Y N	
31.6B	Y N	Y N	Y N	
31.6C	Y N	Y N	Y N	
31.6D	Y N	Y N	Y N	
31.6E	Y N	Y N	Y N	
32A	Y N			
32B	Y N			
32C	Y N			
32D	Y N			
32E	Y N			
32F	Y N			
32G	Y N			
32H	Y N			
32I	Y N			
32J	Y N			
32K	Y N			

Evaluation Site: COLD SPRING POND AA1

Q.#	$\overline{X}$	W	D	COMMENTS/ASSUMPTIONS
				WETLAND CONDITION
33A	Y N			
33B	Y N			
33C	Y N			
33D	Y N			
33E	Y N			
33F	Y N			
33G	Y N			
33H	Y N			
33I	Y N			
33J	Y N			
33K	Y N			
34.1	Y N			- USGS - OBSERVED FIELD DATA
34.2	Y N			
34.3.1	Y N			
34.3.2	Y N I			
35.1	Y N I			FEMA MAP, FIELD OBSERV
35.2	Y N I			
36.1.1	Y N	Y N	Y N	
36.1.2	Y N	Y N	Y N	
36.2.1	Y N	Y N	Y N	
36.2.2	Y N	Y N	Y N	- CATTAILS TUSSOCK SEDGE
36.2.3	Y N	Y N	Y N	
37	Y N			
38.1	Y N			- UPGRADIENT AA
38.2	Y N			
38.3	Y N			
38.4	Y N			
38.5	Y N			
38.6	Y N			
38.7	Y N			- NWI MAP
38.8	Y N I			
39	Y N			
40.1	Y N I			
40.2	Y N I			
41.1		Y N I		
41.2		Y N I		

FORM B (Cont.)

Evaluation Site: Cold Spring Pond AA-1

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D
42.1.1	Y N I	Y N I	Y N I
42.1.2	Y N I	Y N I	Y N I
42.1.3	Y N I	Y N I	Y N I
42.2.1	Y N I	Y N I	Y N I
42.2.2	Y N I	Y N I	Y N I
42.2.3	Y N I	Y N I	Y N I
43A	Y N	Y N	Y N
43B	Y N	Y N	Y N
43C	Y N	Y N	Y N
43D	Y N	Y N	Y N
43E	Y N	Y N	Y N
43F	Y N	Y N	Y N
43G	Y N	Y N	Y N
43H	Y N	Y N	Y N
43I	Y N	Y N	Y N
44A	Y N	Y N	Y N
44B	Y N	Y N	Y N
44C	Y N	Y N	Y N
44D	Y N	Y N	Y N
44E	Y N	Y N	Y N
44F	Y N	Y N	Y N
44G	Y N	Y N	Y N
44H	Y N	Y N	Y N
44I	Y N	Y N	Y N
45A	Y N		
45B	Y N		
45C	Y N		
45D	Y N		
45E	Y N		
45F	Y N		
45G	Y N		
46A	Y N	Y N	Y N
46B	Y N	Y N	Y N
46C	Y N	Y N	Y N
47A	Y N		
47B	Y N		
47C	Y N		

FORM B (Cont.)

Evaluation Site: Cold Spring Pond AA1

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D
48A	Y N I	Y N I	Y N I
48B	Y N I	Y N I	Y N I
48C	Y N I	Y N I	Y N I
48D	Y N I	Y N I	Y N I
48E	Y N I	Y N I	Y N I
48F	Y N I	Y N I	Y N I
49.1.1	Y N I	Y N I	Y N I
49.1.2	Y N I	Y N I	Y N I
49.2	Y N I	Y N I	Y N I
49.3	Y N I	Y N I	Y N I
50.	Y N	Y N	Y N

EFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 3 (DETAILED DATA)

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D
51.1	Y N U		
51.2	Y N U		
52.1	Y N I U		
52.2	Y N I U		
53.1	Y N I U		
53.2	Y N I U		
54	Y N U	Y N U	Y N U
55.1	Y N U		
55.2	Y N U		
55.3	Y N U		
55.4	Y N U		
56.1	Y N I U		
56.2	Y N I U		
57.1	Y N U		
57.2	Y N U		
58.	Y N U		

FORM B (Cont.)

Evaluation Site: ____________________

WETLAND CONDITION				COMMENTS/ASSUMPTIONS
Q.#	$\overline{X}$	W	D	
59.1	Y N I U			
59.2	Y N I U			
60	Y N U			
61	Y N I U			
62	Y N U			
63.1	Y N I U			
63.2	Y N I U			
64		Y N I U		

FORM C: SUPPLEMENTARY OBSERVATIONS

Evaluation Site: GOLD SPRING POND AA#1

Indicate the species, species groups, and activities that are actually observed, reliably reported, or known to occur at the AA on a regular basis.

FISH SPECIES GROUPS*	OBSERVED/REPORTED
1. Warmwater Group	Y or N
2. Coldwater Group	Y or N
3. Northern Lake Group	Y or N
4. Coldwater Riverine Group	Y or N

FISH SPECIES	OBSERVED/REPORTED
22 Yellow Perch 26 Pumpkinseed N	Y or N
10 [illegible]	Y or N
7 Smallmouth Bass	Y or N
40 Redbreasted Sunfish N	

WATERFOWL SPECIES GROUPS**		NESTING	MIGRATING	WINTERING
1. Prairie Dabblers	110	Y or N	Y or N	Y or N
2. Black Duck	113	Y or N	Y or N	Y or N
3. Wood Duck	116	Y or N	Y or N	Y or N
4. Common and Red-Breasted Mergansers	119	Y or N	Y or N	Y or N
5. Hooded Merganser	122	Y or N	Y or N	Y or N
6. Canvasback, Redhead, Ruddy Duck	125	Y or N	Y or N	Y or N
7. Ring-necked Duck	128	Y or N	Y or N	Y or N
8. Greater and Lesser Scaup	131	Y or N	Y or N	Y or N
9. Common Goldeneye	134	Y or N	Y or N	Y or N
10. Bufflehead	137	Y or N	Y or N	Y or N
11. Whistling Ducks	140	Y or N	Y or N	Y or N
12. Inland Geese	143	Y or N	Y or N	Y or N
13. Tundra Swan	146	Y or N	Y or N	Y or N
14. Brant	149	Y or N	Y or N	Y or N

BIRD SPECIES	OBSERVED/REPORTED
✓ [illegible]	Y or N
✓ [illegible]	Y or N
✓ Green Heron	Y or N

RECREATIONAL ACTIVITIES

Hiking, Birdwatching, Photography, Swimming, Sailing, Power Boating, Canoeing, Kayaking, Snowmobiling, Skiing, Snowshoeing, Ice Skating, Research, Educational Fieldtrips, Horseback Riding

CONSUMPTIVE ACTIVITIES

Agriculture, Hunting, Fur Harvesting, Timber Harvest, Commercial/Sport Fishing, Natural Food Gathering, Peat Harvesting, Water Supply

* Fish species groups are explained on page 138
** Waterfowl species groups are explained on page 1647

FORM D: EVALUATION SUMMARY SHEET

Evaluation Site: ____________________

Wetland Functions and Values

	Social Significance	Effectiveness	Opportunity
Ground Water Recharge			*
Ground Water Discharge			*
Floodflow Alteration			
Sediment Stabilization			*
Sediment/Toxicant Retention			
Nutrient Removal/Transform.			
Production Export	*		*
Wildlife Diversity/Abundance**		*	*
Breeding	*		*
Migration	*		*
Wintering	*		*
Aquatic Diversity/Abundance			*
Uniqueness/Heritage		*	*
Recreation		*	*

Habitat Suitability Evaluation

Fish Species Groups:

__________ Group ___ __________ Group ___ __________ Group ___

Waterfowl Species Groups:

	Breeding	Migration	Wintering
Group __________	___	___	___
Group __________	___	___	___
Group __________	___	___	___
Group __________	___	___	___

Fish, Invertebrate, and Bird Species:

__________	___	__________	___	__________	___
__________	___	__________	___	__________	___
__________	___	__________	___	__________	___
__________	___	__________	___	__________	___

Levels of assessment completed: S-1 S-2 E/O-1 E/O-2 E/O-3 HS

Evaluation is for the: AA IA (Note: if the evaluation is for an IA, documentation of the AA evaluation must be presented with this evaluation).

Is there any evidence that suggests ratings contrary to the above (explain)?

____

Were alternative sources used for any of the ratings above (explain)? __________

____

The loss rate for ____________________ (identify locality/region) between 19__ and 19__ for ____________________ (identify wetland type) was __________ (acres/year or % loss).

* WET does not evaluate this function or value in these terms.

** Wildlife Diversity/Abundance assesses only wetland-dependent birds. Other wildlife (e.g., game mammals) should be evaluated using other methods.

POST PLOW

FORM A: SITE DOCUMENTATION (Page 1 of 2)

Part 1 - Background Information

Evaluation Site: PLOWSHOP POND IA 2 POST IMPACT - 3yrs Date: 6/21/93

Site Location (Section, Range, and Township): AYER MA

Has the evaluator taken a training course in WET Version 2.0? Yes

Agencies/Experts Contacted: SCS NOAA

Circle the assessment levels to be completed? SS-1 SS-2 E/O-1&2 E/O-3 HS

Is the wetland tidal or nontidal? If the wetland is nontidal, indicate the month(s) that represent wet, dry, and average conditions, or if only average annual condition will be used, give rationale. Also, indicate if the previous 12 months of precipitation has been above, below, or near normal.
Nontidal, Wet Cond - hydrology - March Veget - May Dry Cond - Hydrol - Aug Veg - Nov. ?, Avg Cond - Hydrol = June Veg. Sept.

Is this evaluation an estimate of past conditions or a prediction of future conditions? (If answer is yes, explain nature and source of predictive data.)
No

Will alternative ratings be used to evaluate any of the functions or values (if yes, explain)? No

Part 2 - Identification and Delineation of Evaluation Areas

Sketch a map on the following page, or attach a suitable map (photocopy of topgraphic map) that shows the following information:

- -- Boundaries of the AA, IA, and IZ, and the location of service areas. See Figure
- -- Watershed boundaries of AA, and service areas.
- -- Extent of surface water in the AA during the wet and dry seasons.
- -- Open water (channels and pools) within and adjacent to the AA.
- -- Normal direction of channel or tidal flow
- -- Normal direction of wind-driven waves or current.
- -- Impact area(s).
- -- Scale of distance and north compass direction.

Explain the procedures used to identify or delineate the AA, IA, IZ, service areas, and the watersheds of these areas if they differed from the guidelines outlined in Section 2.7. N/A

-- Continued --

FORM A: SITE DOCUMENTATION (Page 2 of 2)

Part 2 (Cont.)

Estimate the extent of the following areas:

Assessment Area = N/A acres
Impact Area = ±25 acres (only if applicable)
Watershed of AA = — acres/ ±25 miles^2 (acres x 0.0016 = miles)
Wetlands in AA = ±25 acres
Wetlands in the watershed of closest service area = >500 acres
Wetlands and deepwater in the watershed of closest service area = >500 acres

How were locality and region defined for this evaluation?
Locality - Town (Ayer)
Region - State (Massachusetts)

Sketch of Evaluation Areas (or attach map):

See Figure 1.

FORM B: EVALUATION ANSWER SHEET

Evaluation Site: Plowshop Pond I A-2

SOCIAL SIGNIFICANCE EVALUATION - LEVEL 1

3.1.1 "Red Flags"

Comments/Assumptions

s1.	Y	N	U
s2.	Y	N	U
s3.	Y	N	U
s4.	Y	N	U
s5.	Y	N	U
s6.	Y	N	U

3.1.2 On-site Social Significance

Comments/Assumptions

s7.	Y	N	U	I	
s8.	Y	N	U	I	Superfund site

3.1.3 Off-site Social Significance

					Comments
s9.	Y	N	U	I	"Y" s10
s10.	Y	N	U		ch. due to
s11.	Y	N	U		<10% & open
s12.	Y	N	U		until 77%
s13.	Y	N	U		
s14.	Y	N	U		
s15.	Y	N	U	I	
s16.	Y	N	U	I	
s17.	Y	N	U	I	
s18.	Y	N	U	I	
s19.	Y	N	U		
s20.	Y	N	U		

					Comments
s21.	Y	N	U		
s22.	Y	N	U	I	
s23.	Y	N	U		
s24.	Y	N	U		
s25.	Y	N	U		— Superfund.
s26.	Y	N	U		No SCORP, no deliq.
s27.	Y	N	U		
s28.	Y	N	U		
s29.	Y	N	U		
s30.	Y	N	U		
s31.	Y	N	U		

SOCIAL SIGNIFICANCE EVALUATION - LEVEL 2

Context Region (Circle one)
Standard Density Circle
Locality
Hydrologic Unit

Question #

Comments/Assumptions

1	Y	N	Same as 4A
2	Y	N	
3	Y	N	
4	Y	N	

FORM B (Cont.)

Evaluation Site: Plowshop IA - 2

EFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 1 (OFFICE)

Q.#	WETLAND CONDITION $\overline{X}$	W	D	COMMENTS/ASSUMPTIONS
1.1	Y N			
1.2	Y N			
1.3	Y N			
2.1.1	Y N			
2.1.2	Y N			
2.1.3	Y N			
2.2.1	Y N I			
2.2.2	Y N I			
3.1	Y N			
3.2	Y N			
3.3	Y N			
4.1	Y N - [illegible]			
4.2A	Y N			
4.2B	Y N			
4.2C	Y N			
4.2D	Y N			
5.1.1		Y N		
5.1.2		Y N		
5.2		Y N		
6.1	Y N			
6.2	Y N			
7	Y N I			
8.1	Y N			
8.2	Y N			
8.3	Y N			
8.4	Y N			
9.1		Y N		
9.2		Y N I		
9.3		Y N I		
10A	Y N			
10B	Y N			
10C	Y N			
10D	Y N			
10E	Y N			
10F	Y N			

FORM B (Cont.)

Evaluation Site: Plowshop IA-2

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D
11	Y N	Y N	Y N
12A	Y N	Y N	Y N
12Aa	Y N	Y N	Y N
12Ab	Y N	Y N	Y N
12Ac	Y N	Y N	Y N
12Ad	Y N	Y N	Y N
12Ae	Y N	Y N	Y N
12B	Y N	Y N	Y N
12Ba	Y N	Y N	Y N
12Bb	Y N	Y N	Y N
12Bc	Y N	Y N	Y N
12Bd	Y N	Y N	Y N
12Be	Y N	Y N	Y N
12C	Y N	Y N	Y N
12Ca	Y N	Y N	Y N
12Cb	Y N	Y N	Y N
12Cc	Y N	Y N	Y N
12Cd	Y N	Y N	Y N
12D	Y N	Y N	Y N
12Da	Y N	Y N	Y N
12Db	Y N	Y N	Y N
12E	Y N	Y N	Y N
13A	Y N	Y N	Y N
13Aa	Y N	Y N	Y N
13Ab	Y N	Y N	Y N
13Ac	Y N	Y N	Y N
13Ad	Y N	Y N	Y N
13Ae	Y N	Y N	Y N
13B	Y N	Y N	Y N
13Ba	Y N	Y N	Y N
13Bb	Y N	Y N	Y N
13Bc	Y N	Y N	Y N
13Bd	Y N	Y N	Y N
13Be	Y N	Y N	Y N
13C	Y N	Y N	Y N
13Ca	Y N	Y N	Y N
13Cb	Y N	Y N	Y N
13Cc	Y N	Y N	Y N
13Cd	Y N	Y N	Y N
13D	Y N	Y N	Y N
13Da	Y N	Y N	Y N
13Db	Y N	Y N	Y N
13E	Y N	Y N	Y N

FORM B (Cont.)

Evaluation Site: Plowshop IA-7

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D
14.1	Y N	Y N	Y N
14.2	Y N	Y N	Y N
15.1A	Y N I		
15.1B	Y N I		
15.1C	Y N I		
15.2	Y N I		
16A	Y N	Y N	Y N
16B	Y N	Y N	Y N
16C	Y N	Y N	Y N
17	Y N		
18	Y N I		
19.1A	Y N I		
19.1B	Y N I		
19.2	Y N I		
19.3	Y N I		
20.1	Y N I		
20.2	Y N I		
21A	Y N		
21B	Y N		
21C	Y N		
21D	Y N		
21E	Y N		
22.1.1	Y N		
22.1.2	Y N I		
22.2	Y N		
22.3	Y N I		
23	Y N		
24.1	Y N I		
24.2	Y N I		
24.3	Y N I		
24.4	Y N I		
24.5	Y N		
25.1	Y N		
25.2A	Y N I		
25.2B	Y N I		
25.3	Y N		

FORM B (Cont.)

Evaluation Site: Cold Spring IA-2

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D
26.1	Y N		
26.2	Y N I		
26.3	Y N I		
27.1	Y N		
27.2	Y N I		
27.3	Y N I		

EFFFECTIVENESS/OPPORTUNITY EVALUATION – LEVEL 2 (FIELD)

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D
28	Y N		
29.1	Y N		
29.2	Y N		
30.	Y N	Y N	Y N
31.1	Y N	Y N	Y N
31.2	Y N	Y N	Y N
31.3	Y N	Y N	Y N
31.4	Y N I	Y N I	Y N I
31.5	Y N	Y N	Y N
31.6A	Y N	Y N	Y N
31.6B	Y N	Y N	Y N
31.6C	Y N	Y N	Y N
31.6D	Y N	Y N	Y N
31.6E	Y N	Y N	Y N
32A	Y N		
32B	Y N		
32C	Y N		
32D	Y N		
32E	Y N		
32F	Y N		
32G	Y N		
32H	Y N		
32I	Y N		
32J	Y N		
32K	Y N		

Evaluation Site: Plowshop I-A-2

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D
33A	Y N		
33B	Y N		
33C	Y N		
33D	Y N		
33E	Y N		
33F	Y N		
33G	Y N		
33H	Y N		
33I	Y N		
33J	Y N		
33K	Y N		
34.1	Y N		
34.2	Y N		
34.3.1	Y N		
34.3.2	Y N I		
35.1	Y N I		
35.2	Y N I		
36.1.1	Y N	Y N	Y N
36.1.2	Y N	Y N	Y N
36.2.1	Y N	Y N	Y N
36.2.2	Y N	Y N	Y N
36.2.3	Y N	Y N	Y N
37	Y N		
38.1	Y N		
38.2	Y N		
38.3	Y N		
38.4	Y N		
38.5	Y N		
38.6	Y N		
38.7	Y N		
38.8	Y N I		
39	Y N		
40.1	Y N I		
40.2	Y N I		
41.1		Y N I	
41.2		Y N I	

FORM B (Cont.)

Evaluation Site: Plowshop I+2

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D
42.1.1	Y N I	Y N I	Y N I
42.1.2	Y N I	Y N I	Y N I
42.1.3	Y N I	Y N I	Y N I
42.2.1	Y N I	Y N I	Y N I
42.2.2	Y N I	Y N I	Y N I
42.2.3	Y N I	Y N I	Y N I
43A	Y N	Y N	Y N
43B	Y N	Y N	Y N
43C	Y N	Y N	Y N
43D	Y N	Y N	Y N
43E	Y N	Y N	Y N
43F	Y N	Y N	Y N
43G	Y N	Y N	Y N
43H	Y N	Y N	Y N
43I	Y N	Y N	Y N
44A	Y N	Y N	Y N
44B	Y N	Y N	Y N
44C	Y N	Y N	Y N
44D	Y N	Y N	Y N
44E	Y N	Y N	Y N
44F	Y N	Y N	Y N
44G	Y N	Y N	Y N
44H	Y N	Y N	Y N
44I	Y N	Y N	Y N
45A	Y N		
45B	Y N		
45C	Y N		
45D	Y N		
45E	Y N		
45F	Y N		
45G	Y N		
46A	Y N	Y N	Y N
46B	Y N	Y N	Y N
46C	Y N	Y N	Y N
47A	Y N		
47B	Y N		
47C	Y N		

– assumed, re[illegible] [illegible] [illegible] in maj. of area.

FORM B (Cont.)

Evaluation Site: PlowShop AA2

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	X̄	W	D
48A	Y N I	Y N I	Y N I
48B	Y N I	Y N I	Y N I
48C	Y N I	Y N I	Y N I
48D	Y N I	Y N I	Y N I
48E	Y N I	Y N I	Y N I
48F	Y N I	Y N I	Y N I
49.1.1	Y N I	Y N I	Y N I
49.1.2	Y N I	Y N I	Y N I
49.2	Y N I	Y N I	Y N I
49.3	Y N I	Y N I	Y N I
50.	Y N	Y N	Y N

EFFECTIVENESS/OPPORTUNITY EVALUATION – LEVEL 3 (DETAILED DATA)

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	X̄	W	D
51.1	Y N U		
51.2	Y N U		
52.1	Y N I U		
52.2	Y N I U		
53.1	Y N I U		
53.2	Y N I U		
54	Y N U	Y N U	Y N U
55.1	Y N U		
55.2	Y N U		
55.3	Y N U		
55.4	Y N U		
56.1	Y N I U		
56.2	Y N I U		
57.1	Y N U		
57.2	Y N U		
58.	Y N U		

FORM B (Cont.)

Evaluation Site: ______________________________

	WETLAND CONDITION			COMMENTS/ASSUMPTIONS
Q.#	$\overline{X}$	W	D	
59.1	Y N I U			
59.2	Y N I U			
60	Y N U			
61	Y N I U			
62	Y N U			
63.1	Y N I U			
63.2	Y N I U			
64		Y N I U		

FORM C: SUPPLEMENTARY OBSERVATIONS

Evaluation Site: ______________________________

Indicate the species, species groups, and activities that are actually observed, reliably reported, or known to occur at the AA on a regular basis.

FISH SPECIES GROUPS*	OBSERVED/REPORTED
1. Warmwater Group	Y or N
2. Coldwater Group	Y or N
3. Northern Lake Group	Y or N
4. Coldwater Riverine Group	Y or N

FISH SPECIES	OBSERVED/REPORTED
______________________	Y or N
______________________	Y or N
______________________	Y or N

WATERFOWL SPECIES GROUPS**	OBSERVED/REPORTED		
	NESTING	MIGRATING	WINTERING
1. Prairie Dabblers	Y or N	Y or N	Y or N
2. Black Duck	Y or N	Y or N	Y or N
3. Wood Duck	Y or N	Y or N	Y or N
4. Common and Red-Breasted Mergansers	Y or N	Y or N	Y or N
5. Hooded Merganser	Y or N	Y or N	Y or N
6. Canvasback, Redhead, Ruddy Duck	Y or N	Y or N	Y or N
7. Ring-necked Duck	Y or N	Y or N	Y or N
8. Greater and Lesser Scaup	Y or N	Y or N	Y or N
9. Common Goldeneye	Y or N	Y or N	Y or N
10. Bufflehead	Y or N	Y or N	Y or N
11. Whistling Ducks	Y or N	Y or N	Y or N
12. Inland Geese	Y or N	Y or N	Y or N
13. Tundra Swan	Y or N	Y or N	Y or N
14. Brant	Y or N	Y or N	Y or N

BIRD SPECIES	OBSERVED/REPORTED
______________________	Y or N
______________________	Y or N
______________________	Y or N

RECREATIONAL ACTIVITIES

Hiking	Sailing	Snowmobiling	Research
Birdwatching	Power Boating	Skiing	Educational Fieldtrips
Photography	Canoeing	Snowshoeing	Horseback Riding
Swimming	Kayaking	Ice Skating	

CONSUMPTIVE ACTIVITIES

Agriculture	Fur Harvesting	Commercial/Sport Fishing	Peat Harvesting
Hunting	Timber Harvest	Natural Food Gathering	Water Supply

* Fish species groups are explained on page 138
** Waterfowl species groups are explained on page 1647

FORM D: EVALUATION SUMMARY SHEET

Evaluation Site: ______________________________

Wetland Functions and Values

	Social Significance	Effectiveness	Opportunity
Ground Water Recharge	____	____	*
Ground Water Discharge	____	____	*
Floodflow Alteration	____	____	____
Sediment Stabilization	____	____	*
Sediment/Toxicant Retention	____	____	____
Nutrient Removal/Transform.	____	____	____
Production Export	*	____	*
Wildlife Diversity/Abundance**	____	*	*
Breeding	*	____	*
Migration	*	____	*
Wintering	*	____	*
Aquatic Diversity/Abundance	____	____	*
Uniqueness/Heritage	____	*	*
Recreation	____	*	*

Habitat Suitability Evaluation

Fish Species Groups:

__________ Group ___ __________ Group ___ __________ Group ___

Waterfowl Species Groups:

	Breeding	Migration	Wintering
Group __________	___	___	___
Group __________	___	___	___
Group __________	___	___	___
Group __________	___	___	___

Fish, Invertebrate, and Bird Species:

__________	___	__________	___	__________	___
__________	___	__________	___	__________	___
__________	___	__________	___	__________	___
__________	___	__________	___	__________	___

Levels of assessment completed: S-1 S-2 E/O-1 E/O-2 E/O-3 HS
Evaluation is for the: AA IA (Note: if the evaluation is for an IA, documentation of the AA evaluation must be presented with this evaluation).
Is there any evidence that suggests ratings contrary to the above (explain)?
____
Were alternative sources used for any of the ratings above (explain)? __________
____
The loss rate for ______________________ (identify locality/region) between 19__ and 19__ for ______________________ (identify wetland type) was __________ (acres/year or % loss).

* WET does not evaluate this function or value in these terms.
** Wildlife Diversity/Abundance assesses only wetland-dependent birds. Other wildlife (e.g., game mammals) should be evaluated using other methods.

DATA NAME: PLOWSHOP

FORM A: SITE DOCUMENTATION (Page 1 of 2)

Part 1 - Background Information AA2

Evaluation Site: PLOWSHOP POND-EXIST. Date: 6-18-93

Site Location (Section, Range, and Township): AYER, MA.

Has the evaluator taken a training course in WET Version 2.0? YES

Agencies/Experts Contacted: SCS NOAA MA DF+W

Circle the assessment levels to be completed? SS-1 SS-2 E/O-1&2 E/O-3 HS

Is the wetland tidal or nontidal? If the wetland is nontidal, indicate the month(s) that represent wet, dry, and average conditions, or if only average annual condition will be used, give rationale. Also, indicate if the previous 12 months of precipitation has been above, below, or near normal.
NONTIDAL - WET CONDITIONS - HYDROLOGY - MARCH, VEGET. MAY, DRY COND. - HYDROLOGY - AUG. VEGETATION - NOV. + AVG COND - HYDROL - JUNE, VEG - SEPT.

Is this evaluation an estimate of past conditions or a prediction of future conditions? (If answer is yes, explain nature and source of predictive data.)
NO

Will alternative ratings be used to evaluate any of the functions or values (if yes, explain)? NO

Part 2 - Identification and Delineation of Evaluation Areas

Sketch a map on the following page, or attach a suitable map (photocopy of topgraphic map) that shows the following information:

-- Boundaries of the AA, IA, and IZ, and the location of service areas. (See Figure
-- Watershed boundaries of AA, and service areas.
-- Extent of surface water in the AA during the wet and dry seasons.
-- Open water (channels and pools) within and adjacent to the AA.
-- Normal direction of channel or tidal flow
-- Normal direction of wind-driven waves or current.
-- Impact area(s).
-- Scale of distance and north compass direction.

Explain the procedures used to identify or delineate the AA, IA, IZ, service areas, and the watersheds of these areas if they differed from the guidelines outlined in Section 2.7. N/A

-- Continued --

FORM A: SITE DOCUMENTATION (Page 2 of 2)

Part 2 (Cont.)

Estimate the extent of the following areas:

Assessment Area = ±25 acres
Impact Area = N/A acres (only if applicable).
Watershed of AA = — acres/ ±25 $miles^2$ (acres x 0.0016 = miles)
Wetlands in AA = ±25 acres
Wetlands in the watershed of closest service area = >500 acres
Wetlands and deepwater in the watershed of closest service area = >500 acres

How were locality and region defined for this evaluation?
Locality – Town (AYER)
Region – State (Massachusetts)

Sketch of Evaluation Areas (or attach map):

See Figure 1

FORM B: EVALUATION ANSWER SHEET

Evaluation Site: PLOWSHOP POND AA2

SOCIAL SIGNIFICANCE EVALUATION - LEVEL 1

3.1.1 "Red Flags"

Comments/Assumptions

s1. Y N U - NOT LISTED BY MA. NATURAL HERITAGE
s2. Y N U
s3. Y N U
s4. Y N U
s5. Y N U
s6. Y N U

3.1.2 On-site Social Significance

Comments/Assumptions

s7. Y N U I
s8. Y N U I - SUPERFUND SITE ADJ. PLOWSHOP POND

3.1.3 Off-site Social Significance

Comments

s9. Y N U I
s10. Y N U - "Y" changed to "N" because: 1) <15% ... 2) wells >7%
s11. Y N U
s12. Y N U
s13. Y N U
s14. Y N U
s15. Y N U I - NAT. HER.
s16. Y N U I - GROVE POND WELL FIELD
s17. Y N U I
s18. Y N U I
s19. Y N U
s20. Y N U

Comments

s21. Y N U - BLACK ..., WOOD ...
s22. Y N U I
s23. Y N U
s24. Y N U
s25. Y N U - SUPERFUND SITE
s26. Y N U
s27. Y N U
s28. Y N U
s29. Y N U - MILITARY ...
s30. Y N U
s31. Y N U - ...

SOCIAL SIGNIFICANCE EVALUATION - LEVEL 2

Context Region (Circle one)
Standard Density Circle
Locality
Hydrologic Unit

Question #

Comments/Assumptions

1 Y N -
2 Y N - ...
3 Y N - ... GROVE POND ...
4 Y N - FLOOD ... YEAR ...

FORM B (Cont.)

Evaluation Site: PLOWSHOP POND - FT. DEVENS, AYER, MA - AAZ

EFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 1 (OFFICE)

	WETLAND CONDITION			COMMENTS/ASSUMPTIONS
Q.#	$\overline{X}$	W	D	
1.1	Y N			
1.2	Y N			- EROSIVITY FACTOR 125-50%
1.3	Y N			
2.1.1	Y N			
2.1.2	Y N			
2.1.3	Y N			
2.2.1	Y N I			
2.2.2	Y N I			- USGS TOPO + FIELD OBS.
3.1	Y N			
3.2	Y N			NWI MAP
3.3	Y N			
4.1	Y N			- NASHUA/AYER [illegible] 100 mi
4.2A	Y N			
4.2B	Y N			
4.2C	Y N			
4.2D	Y N			
5.1.1		Y N		~3%
5.1.2		Y N		
5.2		Y N		- [illegible]
6.1	Y N			
6.2	Y N			
7	Y N I			
8.1	Y N			
8.2	Y N			
8.3	Y N			
8.4	Y N			
9.1		Y N		- constr. outlet - a & c true
9.2		Y N I		
9.3		Y N I		
10A	Y N			
10B	Y N			
10C	Y N			
10D	Y N			
10E	Y N			
10F	Y N			

FORM B (Cont.)

Evaluation Site: PLOWSHOP POND AA-2

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D
11	Y N	Y N	Y N
12A	Y N	Y N	Y N
12Aa	Y N	Y N	Y N
12Ab	Y N	Y N	Y N
12Ac	Y N	Y N	Y N
12Ad	Y N	Y N	Y N
12Ae	Y N	Y N	Y N
12B	Y N	Y N	Y N
12Ba	Y N	Y N	Y N
12Bb	Y N	Y N	Y N
12Bc	Y N	Y N	Y N
12Bd	Y N	Y N	Y N
12Be	Y N	Y N	Y N
12C	Y N	Y N	Y N
12Ca	Y N	Y N	Y N
12Cb	Y N	Y N	Y N
12Cc	Y N	Y N	Y N
12Cd	Y N	Y N	Y N
12D	Y N	Y N	Y N
12Da	Y N	Y N	Y N
12Db	Y N	Y N	Y N
12E	Y N	Y N	Y N
13A	Y N	Y N	Y N
13Aa	Y N	Y N	Y N
13Ab	Y N	Y N	Y N
13Ac	Y N	Y N	Y N
13Ad	Y N	Y N	Y N
13Ae	Y N	Y N	Y N
13B	Y N	Y N	Y N
13Ba	Y N	Y N	Y N
13Bb	Y N	Y N	Y N
13Bc	Y N	Y N	Y N
13Bd	Y N	Y N	Y N
13Be	Y N	Y N	Y N
13C	Y N	Y N	Y N
13Ca	Y N	Y N	Y N
13Cb	Y N	Y N	Y N
13Cc	Y N	Y N	Y N
13Cd	Y N	Y N	Y N
13D	Y N	Y N	Y N
13Da	Y N	Y N	Y N
13Db	Y N	Y N	Y N
13E	Y N	Y N	Y N

Dominant AA - Aquatic Bed, Rooted Vascular

Edge B - Broad Leaved Deciduous

C - Aquatic Bed Rooted Vascular

>10% - Aquatic Bed

>1 Acre - Shrub Scrub along shoreline

Evaluation Site: PLOWSHOP POND AA2

Q.#	$\overline{X}$	W	D	COMMENTS/ASSUMPTIONS
				WETLAND CONDITION
14.1	Y N	Y N	Y N	- NONE OBSERVED
14.2	Y N	Y N	Y N	
15.1A	Y N I			
15.1B	Y N I			
15.1C	Y N I			
15.2	Y N I			NO CHANNEL [illegible]
16A	Y N	Y N	Y N	PRESENT AQUATIC BED
16B	Y N	Y N	Y N	
16C	Y N	Y N	Y N	
17	Y N			>70% AQUATIC BED OVER ~30 ACRES
18	Y N I			REGULAR W/2 COVES
19.1A	Y N I - 22 [illegible], LAND [illegible] TOPO [illegible]			
19.1B	Y N I			
19.2	Y N I			
19.3	Y N I - VEG [illegible]			
20.1	Y N I			
20.2	Y N I			
21A	Y N [illegible]			
21B	Y N			
21C	Y N			
21D	Y N			
21E	Y N			
22.1.1	Y N			
22.1.2	Y N I			
22.2	Y N			
22.3	Y N I			
23	Y N DAM [illegible]			
24.1	Y N I - SCS SOIL MAPS			
24.2	Y N I			
24.3	Y N I			
24.4	Y N I			
24.5	Y N			
25.1	Y N - LANDFILL			
25.2A	Y N I			
25.2B	Y N I			
25.3	Y N - UNSTABLE SANDY SOILS			

Evaluation Site: ____________________

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D	
26.1	Y N			— LANDFILL
26.2	Y N I			— GRNDWTR DITCH
26.3	Y N I			
27.1	Y N			LANDFILL
27.2	Y N I			
27.3	Y N I			

EFFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 2 (FIELD)

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D	
28	Y N			
29.1	Y N			— [illegible]
29.2	Y N			
30.	Y N	Y N	Y N	
31.1	Y N	Y N	Y N	
31.2	Y N	Y N	Y N	
31.3	Y N	Y N	Y N	
31.4	Y N I	Y N I	Y N I	[illegible]
31.5	Y N	Y N	Y N	
31.6A	Y N	Y N	Y N	
31.6B	Y N	Y N	Y N	
31.6C	Y N	Y N	Y N	
31.6D	Y N	Y N	Y N	
31.6E	Y N	Y N	Y N	

Q.#	$\bar{X}$
32A	Y N
32B	Y N
32C	Y N
32D	Y N
32E	Y N
32F	Y N
32G	Y N
32H	Y N
32I	Y N
32J	Y N
32K	Y N

FORM B (Cont.)

Evaluation Site: ______________________________

Q.#	$\bar{X}$	W	D	COMMENTS/ASSUMPTIONS
33A	Y N			
33B	Y N			
33C	Y N			
33D	Y N			
33E	Y N			
33F	Y N			
33G	Y N			
33H	Y N			
33I	Y N			
33J	Y N			
33K	Y N			
34.1	Y N – DAM [illegible] – ON OLD USGS MAPS			
34.2	Y N			
34.3.1	Y N			
34.3.2	Y N I			
35.1	Y N I			
35.2	Y N I			
36.1.1	Y N	Y N	Y N	
36.1.2	Y N	Y N	Y N	
36.2.1	Y N	Y N	Y N	
36.2.2	Y N	Y N	Y N	
36.2.3	Y N	Y N	Y N	
37	Y N			
38.1	Y N – DAM [illegible] DOWNSTREAM – [illegible]			
38.2	Y N			
38.3	Y N			
38.4	Y N			
38.5	Y N			
38.6	Y N			
38.7	Y N – FLOOD[illegible] < 1 mi downstream			
38.8	Y N I			
39	Y N	TREES [illegible] MAST-BEARING [illegible]		
40.1	Y N I			
40.2	Y N I			
41.1		Y N I		
41.2		Y N I		

FORM B (Cont.)

Evaluation Site: ______________________________

Q.#	$\overline{X}$	W	D	COMMENTS/ASSUMPTIONS
42.1.1	Y N I	Y N I	Y N I	
42.1.2	Y N I	Y N I	Y N I	
42.1.3	Y N I	Y N I	Y N I	
42.2.1	Y N I	Y N I	Y N I	- DOWNSTREAM RIVER
42.2.2	Y N I	Y N I	Y N I	INACCE[illegible] TO F[illegible]
42.2.3	Y N I	Y N I	Y N I	DUE TO DAM.
43A	Y N	Y N	Y N	
43B	Y N	Y N	Y N	
43C	Y N	Y N	Y N	
43D	Y N	Y N	Y N	
43E	Y N	Y N	Y N	- ECOL ENVIR REPORT
43F	Y N	Y N	Y N	PG 3-30 4/95
43G	Y N	Y N	Y N	
43H	Y N	Y N	Y N	
43I	Y N	Y N	Y N	
44A	Y N	Y N	Y N	
44B	Y N	Y N	Y N	
44C	Y N	Y N	Y N	
44D	Y N	Y N	Y N	FIELD OBSERV
44E	Y N	Y N	Y N	OF AQUATICS
44F	Y N	Y N	Y N	
44G	Y N	Y N	Y N	
44H	Y N	Y N	Y N	
44I	Y N	Y N	Y N	
45A	Y N			
45B	Y N			
45C	Y N			
45D	Y N			
45E	Y N			
45F	Y N			
45G	Y N			
46A	Y N	Y N	Y N	
46B	Y N	Y N	Y N	
46C	Y N	Y N	Y N	
47A	Y N			
47B	Y N	ESL 8/91 [illegible]		
47C	Y N			

WETLAND CONDITION

FORM B (Cont.)

Evaluation Site: ____________________

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D	COMMENTS/ASSUMPTIONS
48A	Y N I	Y N I	Y N I	
48B	Y N I	Y N I	Y N I	
48C	Y N I	Y N I	Y N I	
48D	Y N I	Y N I	Y N I	
48E	Y N I	Y N I	Y N I	
48F	Y N I	Y N I	Y N I	
49.1.1	Y N I	Y N I	Y N I	- DAM [illegible]
49.1.2	Y N I	Y N I	Y N I	
49.2	Y N I	Y N I	Y N I	
49.3	Y N I	Y N I	Y N I	
50.	Y N	Y N	Y N	RICH DIVERSITY

EFFECTIVENESS/OPPORTUNITY EVALUATION – LEVEL 3 (DETAILED DATA)

WETLAND CONDITION — COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D	COMMENTS/ASSUMPTIONS
51.1	Y N U			
51.2	Y N U			
52.1	Y N I U			
52.2	Y N I U			
53.1	Y N I U			
53.2	Y N I U			
54	Y N U	Y N U	Y N U	
55.1	Y N U			
55.2	Y N U			
55.3	Y N U			
55.4	Y N U			
56.1	Y N I U			
56.2	Y N I U			
57.1	Y N U			
57.2	Y N U			
58.	Y N U			

FORM B (Cont.)

Evaluation Site: ______________________

		WETLAND CONDITION		COMMENTS/ASSUMPTIONS
Q.#	$\overline{X}$	W	D	
59.1	Y N I U			
59.2	Y N I U			
60	Y N U			
61	Y N I U			
62	Y N U			
63.1	Y N I U			
63.2	Y N I U			
64		Y N I U		

FORM C: SUPPLEMENTARY OBSERVATIONS

Evaluation Site: AA2 Plowshop Pond

Indicate the species, species groups, and activities that are actually observed, reliably reported, or known to occur at the AA on a regular basis.

FISH SPECIES GROUPS*	OBSERVED/REPORTED
1. Warmwater Group	Y or N
2. Coldwater Group	Y or N
3. Northern Lake Group	Y or N
4. Coldwater Riverine Group	Y or N

FISH SPECIES	OBSERVED/REPORTED
[illegible]	Y or N
[illegible]	Y or N
[illegible]	Y or N

WATERFOWL SPECIES GROUPS**		OBSERVED/REPORTED NESTING	MIGRATING		WINTERING
1. Prairie Dabblers		Y or N	Y or N		Y or N
- 2. Black Duck		Y or N	Y or N		Y or N
- 3. Wood Duck		Y or N	117 Y or N	118	Y or N
4. Common and Red-Breasted Mergansers	119	Y or N	Y or N		Y or N
5. Hooded Merganser	122	Y or N	Y or N		Y or N
6. Canvasback, Redhead, Ruddy Duck	125	Y or N	Y or N		Y or N
7. Ring-necked Duck	128	Y or N	Y or N		Y or N
8. Greater and Lesser Scaup	131	Y or N	Y or N		Y or N
9. Common Goldeneye	134	Y or N	Y or N		Y or N
10. Bufflehead	137	Y or N	Y or N		Y or N
11. Whistling Ducks	140	Y or N	Y or N		Y or N
12. Inland Geese	143	Y or N	Y or N		Y or N
13. Tundra Swan	146	Y or N	Y or N		Y or N
14. Brant	149	Y or N	Y or N		Y or N

best judgement very little data available on actual waterfowl use of this pond.

BIRD SPECIES	OBSERVED/REPORTED
Double-crested Cormorant (fish-eater)	Y or N
208 Belted Kingfisher	Y or N
249 Spotted Sandpiper	Y or N

Tree swallow 224

RECREATIONAL ACTIVITIES

Hiking	Sailing	Snowmobiling	Research
Birdwatching	Power Boating	Skiing	Educational Fieldtrips
Photography	Canoeing	Snowshoeing	Horseback Riding
Swimming	Kayaking	Ice Skating	

CONSUMPTIVE ACTIVITIES

Agriculture	Fur Harvesting	Commercial/Sport Fishing — catch + release only	Peat Harvesting
Hunting	Timber Harvest	Natural Food Gathering	Water Supply

gun shells found in water

* Fish species groups are explained on page 138

** Waterfowl species groups are explained on page 1647

FORM D: EVALUATION SUMMARY SHEET

Evaluation Site: ____

Wetland Functions and Values

	Social Significance	Effectiveness	Opportunity
Ground Water Recharge			*
Ground Water Discharge			*
Floodflow Alteration			
Sediment Stabilization			*
Sediment/Toxicant Retention			
Nutrient Removal/Transform.			
Production Export	*		*
Wildlife Diversity/Abundance**		*	*
Breeding	*		*
Migration	*		*
Wintering	*		*
Aquatic Diversity/Abundance			*
Uniqueness/Heritage		*	*
Recreation		*	*

Habitat Suitability Evaluation

Fish Species Groups:

______________ Group ___ ______________ Group ___ ______________ Group ___

Waterfowl Species Groups:

	Breeding	Migration	Wintering
Group ______________	___	___	___
Group ______________	___	___	___
Group ______________	___	___	___
Group ______________	___	___	___

Fish, Invertebrate, and Bird Species:

______________	___	______________	___	______________	___
______________	___	______________	___	______________	___
______________	___	______________	___	______________	___
______________	___	______________	___	______________	___

Levels of assessment completed: S-1 S-2 E/O-1 E/O-2 E/O-3 HS
Evaluation is for the: AA IA (Note: if the evaluation is for an IA, documentation of the AA evaluation must be presented with this evaluation).
Is there any evidence that suggests ratings contrary to the above (explain)?
____
Were alternative sources used for any of the ratings above (explain)? ________
____
The loss rate for ______________________ (identify locality/region) between 19__ and 19__ for ______________________(identify wetland type) was ______________ (acres/year or % loss).

* WET does not evaluate this function or value in these terms.
** Wildlife Diversity/Abundance assesses only wetland-dependent birds. Other wildlife (e.g., game mammals) should be evaluated using other methods.

POST COLD

FORM A: SITE DOCUMENTATION (Page 1 of 2)

Part 1 - Background Information

Evaluation Site: COLD SPRING POND IA 1 POST-IMPACT - 3 yrs Date: 6/21/93

Site Location (Section, Range, and Township): AYER MA

Has the evaluator taken a training course in WET Version 2.0? YES

Agencies/Experts Contacted: SCS NOAA MA DF+W

Circle the assessment levels to be completed? SS-1 SS-2 E/O-1&2 E/O-3 HS

Is the wetland tidal or nontidal? If the wetland is nontidal, indicate the month(s) that represent wet, dry, and average conditions, or if only average annual condition will be used, give rationale. Also, indicate if the previous 12 months of precipitation has been above, below, or near normal.
NONTIDAL, Wet Cond - hydr - March veg - May Dry Cond - Hydrol - Aug veg - Nov, Avg Cond - Hydrol - June Veg Sept

Is this evaluation an estimate of past conditions or a prediction of future conditions? (If answer is yes, explain nature and source of predictive data.)
NO

Will alternative ratings be used to evaluate any of the functions or values (if yes, explain)? NO

Part 2 - Identification and Delineation of Evaluation Areas

Sketch a map on the following page, or attach a suitable map (photocopy of topgraphic map) that shows the following information: SEE FIGURE 1

- -- Boundaries of the AA, IA, and IZ, and the location of service areas.
- -- Watershed boundaries of AA, and service areas.
- -- Extent of surface water in the AA during the wet and dry seasons.
- -- Open water (channels and pools) within and adjacent to the AA.
- -- Normal direction of channel or tidal flow
- -- Normal direction of wind-driven waves or current.
- -- Impact area(s).
- -- Scale of distance and north compass direction.

Explain the procedures used to identify or delineate the AA, IA, IZ, service areas, and the watersheds of these areas if they differed from the guidelines outlined in Section 2.7. N/A

-- Continued --

FORM A: SITE DOCUMENTATION (Page 2 of 2)

Part 2 (Cont.)

Estimate the extent of the following areas:

Assessment Area = N/A acres
Impact Area = ± 3 acres (only if applicable)
Watershed of AA = ± 50 acres/ 0.08 miles^2 (acres x 0.0016 = miles)
Wetlands in AA = ± 3 acres
Wetlands in the watershed of closest service area = >500 acres
Wetlands and deepwater in the watershed of closest service area = >500 acres

How were locality and region defined for this evaluation?
Locality - Town
Region - State

Sketch of Evaluation Areas (or attach map):

See Figure 1

FORM B: EVALUATION ANSWER SHEET

Evaluation Site: Cold Spring Pond I A-1

SOCIAL SIGNIFICANCE EVALUATION - LEVEL 1

3.1.1 "Red Flags"

Comments/Assumptions

s1. Y N U
s2. Y N U
s3. Y N U
s4. Y N U
s5. Y N U
s6. Y N U

3.1.2 On-site Social Significance

Comments/Assumptions

s7. Y N U I
s8. Y N U I Superfund site

3.1.3 Off-site Social Significance

		Comments			Comments
s9.	Y N U I	"Y"	s21.	Y N U	
s10.	Y N U	S10	s22.	Y N U I	
s11.	Y N U	Ch. due to	s23.	Y N U	
s12.	Y N U	≤10% emph.	s24.	Y N U	
s13.	Y N U	open water > 7%	s25.	Y N U	-Superfund
s14.	Y N U		s26.	Y N U	No SCORP, no dredg
s15.	Y N U I		s27.	Y N U	
s16.	Y N U I		s28.	Y N U	
s17.	Y N U I		s29.	Y N U	
s18.	Y N U I		s30.	Y N U	
s19.	Y N U		s31.	Y N U	
s20.	Y N U				

SOCIAL SIGNIFICANCE EVALUATION - LEVEL 2

Context Region (Circle one)
Standard Density Circle
Locality
Hydrologic Unit

Question #

Comments/Assumptions

1 Y N
2 Y N same as 4-4
3 Y N
4 Y N

FORM B (Cont.)

Evaluation Site: Cold Spring IA-1

EFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 1 (OFFICE)

Q.#	WETLAND CONDITION $\bar{X}$	W	D	COMMENTS/ASSUMPTIONS
1.1	Y N			
1.2	Y N			
1.3	Y N			
2.1.1	Y N			
2.1.2	Y N			
2.1.3	Y N			
2.2.1	Y N I			
2.2.2	Y N I			
3.1	Y N			
3.2	Y N			
3.3	Y N			
4.1	Y N [illegible]			
4.2A	Y N			
4.2B	Y N			
4.2C	Y N			
4.2D	Y N			
5.1.1		Y N		
5.1.2		Y N		
5.2		Y N		
6.1	Y N			
6.2	Y N			
7	Y N I			
8.1	Y N			
8.2	Y N			
8.3	Y N			
8.4	Y N			
9.1		Y N		
9.2		Y N I		
9.3		Y N I		
10A	Y N			
10B	Y N			
10C	Y N			
10D	Y N			
10E	Y N			
10F	Y N			

FORM B (Cont.)

Evaluation Site: Cold Sp T-1

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	X̄	W	D
11	Y N	Y N	Y N
12A	Y N	Y N	Y N
12Aa	Y N	Y N	Y N
12Ab	Y N	Y N	Y N
12Ac	Y N	Y N	Y N
12Ad	Y N	Y N	Y N
12Ae	Y N	Y N	Y N
12B	Y N	Y N	Y N
12Ba	Y N	Y N	Y N
12Bb	Y N	Y N	Y N
12Bc	Y N	Y N	Y N
12Bd	Y N	Y N	Y N
12Be	Y N	Y N	Y N
12C	Y N	Y N	Y N
12Ca	Y N	Y N	Y N
12Cb	Y N	Y N	Y N
12Cc	Y N	Y N	Y N
12Cd	Y N	Y N	Y N
12D	Y N	Y N	Y N
12Da	Y N	Y N	Y N
12Db	Y N	Y N	Y N
12E	Y N	Y N	Y N
13A	Y N	Y N	Y N
13Aa	Y N	Y N	Y N
13Ab	Y N	Y N	Y N
13Ac	Y N	Y N	Y N
13Ad	Y N	Y N	Y N
13Ae	Y N	Y N	Y N
13B	Y N	Y N	Y N
13Ba	Y N	Y N	Y N
13Bb	Y N	Y N	Y N
13Bc	Y N	Y N	Y N
13Bd	Y N	Y N	Y N
13Be	Y N	Y N	Y N
13C	Y N	Y N	Y N
13Ca	Y N	Y N	Y N
13Cb	Y N	Y N	Y N
13Cc	Y N	Y N	Y N
13Cd	Y N	Y N	Y N
13D	Y N	Y N	Y N
13Da	Y N	Y N	Y N
13Db	Y N	Y N	Y N
13E	Y N	Y N	Y N

FORM B (Cont.)

Evaluation Site: Cold Spring IA-1

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	X̄	W	D
14.1	Y N	Y N	Y N
14.2	Y N	Y N	Y N
15.1A	Y N I		
15.1B	Y N I		
15.1C	Y N I		
15.2	Y N I		
16A	Y N	Y N	Y N
16B	Y N	Y N	Y N
16C	Y N	Y N	Y N
17	Y N		
18	Y N I		
19.1A	Y N I		
19.1B	Y N I		
19.2	Y N I		
19.3	Y N I		
20.1	Y N I		
20.2	Y N I		
21A	Y N		
21B	Y N		
21C	Y N		
21D	Y N		
21E	Y N		
22.1.1	Y N		
22.1.2	Y N I		
22.2	Y N		
22.3	Y N I		
23	Y N		
24.1	Y N I		
24.2	Y N I		
24.3	Y N I		
24.4	Y N I		
24.5	Y N		
25.1	Y N		
25.2A	Y N I		
25.2B	Y N I		
25.3	Y N		

FORM B (Cont.)

Evaluation Site: Cold Spring I-1-1

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D
26.1	Y N		
26.2	Y N I		
26.3	Y N I		
27.1	Y N		
27.2	Y N I		
27.3	Y N I		

EFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 2 (FIELD)

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D
28	Y N		
29.1	Y N		
29.2	Y N		
30.	Y N	Y N	Y N
31.1	Y N	Y N	Y N
31.2	Y N	Y N	Y N
31.3	Y N	Y N	Y N
31.4	Y N I	Y N I	Y N I
31.5	Y N	Y N	Y N
31.6A	Y N	Y N	Y N
31.6B	Y N	Y N	Y N
31.6C	Y N	Y N	Y N
31.6D	Y N	Y N	Y N
31.6E	Y N	Y N	Y N
32A	Y N		
32B	Y N		
32C	Y N		
32D	Y N		
32E	Y N		
32F	Y N		
32G	Y N		
32H	Y N		
32I	Y N		
32J	Y N		
32K	Y N		

FORM B (Cont.)

Evaluation Site: Cold Spring I A-1

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D
33A	Y N		
33B	Y N		
33C	Y N		
33D	Y N		
33E	Y N		
33F	Y N		
33G	Y N		
33H	Y N		
33I	Y N		
33J	Y N		
33K	Y N		
34.1	Y N		
34.2	Y N		
34.3.1	Y N		
34.3.2	Y N I		
35.1	Y N I		
35.2	Y N I		
36.1.1	Y N	Y N	Y N
36.1.2	Y N	Y N	Y N
36.2.1	Y N	Y N	Y N
36.2.2	Y N	Y N	Y N
36.2.3	Y N	Y N	Y N
37	Y N		
38.1	Y N		
38.2	Y N		
38.3	Y N		
38.4	Y N		
38.5	Y N		
38.6	Y N		
38.7	Y N		
38.8	Y N I		
39	Y N		
40.1	Y N I		
40.2	Y N I		
41.1		Y N I	
41.2		Y N I	

FORM B (Cont.)

Evaluation Site: Cold Springs IA-1

WETLAND CONDITION COMMENTS/ASSUMPTIONS

Q.#	$\overline{X}$	W	D
42.1.1	Y N I	Y N I	Y N I
42.1.2	Y N I	Y N I	Y N I
42.1.3	Y N I	Y N I	Y N I
42.2.1	Y N I	Y N I	Y N I
42.2.2	Y N I	Y N I	Y N I
42.2.3	Y N I	Y N I	Y N I
43A	Y N	Y N	Y N
43B	Y N	Y N	Y N
43C	Y N	Y N	Y N
43D	Y N	Y N	Y N
43E	Y N	Y N	Y N
43F	Y N	Y N	Y N
43G	Y N	Y N	Y N
43H	Y N	Y N	Y N
43I	Y N	Y N	Y N
44A	Y N	Y N	Y N
44B	Y N	Y N	Y N
44C	Y N	Y N	Y N
44D	Y N	Y N	Y N
44E	Y N	Y N	Y N
44F	Y N	Y N	Y N
44G	Y N	Y N	Y N
44H	Y N	Y N	Y N
44I	Y N	Y N	Y N
45A	Y N		
45B	Y N		
45C	Y N		
45D	Y N		
45E	Y N		
45F	Y N		
45G	Y N		
46A	Y N	Y N	Y N
46B	Y N	Y N	Y N
46C	Y N	Y N	Y N
47A	Y N		
47B	Y N		
47C	Y N		

FORM B (Cont.)

Evaluation Site: Cold Sp. AA1

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D
48A	Y N I	Y N I	Y N I
48B	Y N I	Y N I	Y N I
48C	Y N I	Y N I	Y N I
48D	Y N I	Y N I	Y N I
48E	Y N I	Y N I	Y N I
48F	Y N I	Y N I	Y N I
49.1.1	Y N I	Y N I	Y N I
49.1.2	Y N I	Y N I	Y N I
49.2	Y N I	Y N I	Y N I
49.3	Y N I	Y N I	Y N I
50.	Y N	Y N	Y N

EFFECTIVENESS/OPPORTUNITY EVALUATION - LEVEL 3 (DETAILED DATA)

WETLAND CONDITION

COMMENTS/ASSUMPTIONS

Q.#	$\bar{X}$	W	D
51.1	Y N U		
51.2	Y N U		
52.1	Y N I U		
52.2	Y N I U		
53.1	Y N I U		
53.2	Y N I U		
54	Y N U	Y N U	Y N U
55.1	Y N U		
55.2	Y N U		
55.3	Y N U		
55.4	Y N U		
56.1	Y N I U		
56.2	Y N I U		
57.1	Y N U		
57.2	Y N U		
58.	Y N U		

FORM C: SUPPLEMENTARY OBSERVATIONS

Evaluation Site: ______________________________

Indicate the species, species groups, and activities that are actually observed, reliably reported, or known to occur at the AA on a regular basis.

FISH SPECIES GROUPS*	OBSERVED/REPORTED
1. Warmwater Group	Y or N
2. Coldwater Group	Y or N
3. Northern Lake Group	Y or N
4. Coldwater Riverine Group	Y or N

FISH SPECIES	OBSERVED/REPORTED
______________	Y or N
______________	Y or N
______________	Y or N

WATERFOWL SPECIES GROUPS**	OBSERVED/REPORTED		
	NESTING	MIGRATING	WINTERING
1. Prairie Dabblers	Y or N	Y or N	Y or N
2. Black Duck	Y or N	Y or N	Y or N
3. Wood Duck	Y or N	Y or N	Y or N
4. Common and Red-Breasted Mergansers	Y or N	Y or N	Y or N
5. Hooded Merganser	Y or N	Y or N	Y or N
6. Canvasback, Redhead, Ruddy Duck	Y or N	Y or N	Y or N
7. Ring-necked Duck	Y or N	Y or N	Y or N
8. Greater and Lesser Scaup	Y or N	Y or N	Y or N
9. Common Goldeneye	Y or N	Y or N	Y or N
10. Bufflehead	Y or N	Y or N	Y or N
11. Whistling Ducks	Y or N	Y or N	Y or N
12. Inland Geese	Y or N	Y or N	Y or N
13. Tundra Swan	Y or N	Y or N	Y or N
14. Brant	Y or N	Y or N	Y or N

BIRD SPECIES	OBSERVED/REPORTED
______________	Y or N
______________	Y or N
______________	Y or N

RECREATIONAL ACTIVITIES

Hiking	Sailing	Snowmobiling	Research
Birdwatching	Power Boating	Skiing	Educational Fieldtrips
Photography	Canoeing	Snowshoeing	Horseback Riding
Swimming	Kayaking	Ice Skating	

CONSUMPTIVE ACTIVITIES

Agriculture	Fur Harvesting	Commercial/Sport Fishing	Peat Harvesting
Hunting	Timber Harvest	Natural Food Gathering	Water Supply

* Fish species groups are explained on page 138
** Waterfowl species groups are explained on page 1647

FORM D: EVALUATION SUMMARY SHEET

Evaluation Site: ______________________________

Wetland Functions and Values

	Social Significance	Effectiveness	Opportunity
Ground Water Recharge	____	____	*
Ground Water Discharge	____	____	*
Floodflow Alteration	____	____	____
Sediment Stabilization	____	____	*
Sediment/Toxicant Retention	____	____	____
Nutrient Removal/Transform.	____	____	____
Production Export	*	____	*
Wildlife Diversity/Abundance**	____	*	*
Breeding	*	____	*
Migration	*	____	*
Wintering	*	____	*
Aquatic Diversity/Abundance	____	____	*
Uniqueness/Heritage	____	*	*
Recreation	____	*	*

Habitat Suitability Evaluation

Fish Species Groups:

__________ Group ___ __________ Group ___ __________ Group ___

Waterfowl Species Groups:

	Breeding	Migration	Wintering
Group __________	___	___	___
Group __________	___	___	___
Group __________	___	___	___
Group __________	___	___	___

Fish, Invertebrate, and Bird Species:

__________	___	__________	___	__________	___
__________	___	__________	___	__________	___
__________	___	__________	___	__________	___
__________	___	__________	___	__________	___

Levels of assessment completed: S-1 S-2 E/O-1 E/O-2 E/O-3 HS
Evaluation is for the: AA IA (Note: if the evaluation is for an IA, documentation of the AA evaluation must be presented with this evaluation).
Is there any evidence that suggests ratings contrary to the above (explain)?

____

Were alternative sources used for any of the ratings above (explain)? __________

____

The loss rate for ______________________ (identify locality/region) between 19__ and 19__ for ______________________ (identify wetland type) was __________ (acres/year or % loss).

* WET does not evaluate this function or value in these terms.
** Wildlife Diversity/Abundance assesses only wetland-dependent birds. Other wildlife (e.g., game mammals) should be evaluated using other methods.

****

Habitat Suitability Evaluation Results for "plowshop"

****

Species/Group	Rating	Observed
Warmwater Fish Group	H	y
Warmwater Fish Group	H	y
Warmwater Fish Group	H	y
Northern Lake Fish Group	H	y
Coldwater Fish Group	L	n
Coldwater Riverine Fish Group	L	n
Waterfowl Group 1 (Breeding)	L	y
Waterfowl Group 1 (Migration)	L	y
Waterfowl Group 1 (Wintering)	L	y
Waterfowl Group 2 (Breeding)	L	n
Waterfowl Group 2 (Migration)	L	y
Waterfowl Group 2 (Wintering)	L	n
Waterfowl Group 3 (Breeding)	M	n
Waterfowl Group 3 (Wintering)	L	n
Waterfowl Group 4 (Breeding)	L	n
Waterfowl Group 4 (Migration)	L	y
Waterfowl Group 4 (Wintering)	L	n
Waterfowl Group 5 (Breeding)	L	n
Waterfowl Group 5 (Migration)	H	y
Waterfowl Group 5 (Wintering)	L	n
Waterfowl Group 6 (Breeding)	L	n
Waterfowl Group 6 (Migration)	M	n
Waterfowl Group 6 (Wintering)	L	n
Waterfowl Group 7 (Breeding)	L	n
Waterfowl Group 7 (Migration)	L	y
Waterfowl Group 7 (Wintering)	L	n
Waterfowl Group 8 (Breeding)	L	n
Waterfowl Group 8 (Migration)	L	n
Waterfowl Group 8 (Wintering)	L	n
Waterfowl Group 9 (Breeding)	L	n
Waterfowl Group 9 (Migration)	M	n
Waterfowl Group 9 (Wintering)	L	n
Waterfowl Group 10 (Breeding)	L	n
Waterfowl Group 10 (Migration)	M	n
Waterfowl Group 10 (Wintering)	L	n
Waterfowl Group 11 (Breeding)	L	n
Waterfowl Group 11 (Migration)	L	n
Waterfowl Group 11 (Wintering)	L	n
Waterfowl Group 12 (Breeding)	L	y
Waterfowl Group 12 (Migration)	H	y
Waterfowl Group 12 (Wintering)	L	n
Waterfowl Group 13 (Breeding)	L	n
Waterfowl Group 13 (Migration)	L	n
Waterfowl Group 13 (Wintering)	L	n
Waterfowl Group 14 (Breeding)	L	n
Waterfowl Group 14 (Migration)	M	n
Waterfowl Group 14 (Wintering)	L	n
Belted Kingfisher	L	y
Spotted Sandpiper	L	y
Tree Swallow	M	y

****

Habitat Suitability Evaluation Results for "coldsprin"

****

Species/Group	Rating	Observed
Warmwater Fish Group	M	n
Coldwater Fish Group	L	n
Coldwater Riverine Fish Group	L	n
Northern Lake Fish Group	H	n
Yellow Perch	H	y
Bluegill	H	y
Smallmouth Bass	M	y
Redbreast Sunfish	H	y
Pumpkinseed	H	y
Waterfowl Group 1 (Breeding)	L	n
Waterfowl Group 1 (Migration)	H	y
Waterfowl Group 1 (Wintering)	L	n
Waterfowl Group 2 (Breeding)	L	n
Waterfowl Group 2 (Migration)	H	y
Waterfowl Group 2 (Wintering)	L	n
Waterfowl Group 3 (Breeding)	H	y
Waterfowl Group 3 (Migration)	H	y
Waterfowl Group 3 (Wintering)	L	n
Waterfowl Group 4 (Breeding)	L	n
Waterfowl Group 4 (Migration)	L	y
Waterfowl Group 4 (Wintering)	L	n
Waterfowl Group 5 (Breeding)	L	n
Waterfowl Group 5 (Migration)	H	y
Waterfowl Group 5 (Wintering)	L	n
Waterfowl Group 6 (Breeding)	L	n
Waterfowl Group 6 (Migration)	M	n
Waterfowl Group 6 (Wintering)	L	n
Waterfowl Group 7 (Breeding)	L	n
Waterfowl Group 7 (Migration)	L	y
Waterfowl Group 7 (Wintering)	L	n
Waterfowl Group 8 (Breeding)	L	n
Waterfowl Group 8 (Migration)	L	n
Waterfowl Group 8 (Wintering)	L	n
Waterfowl Group 9 (Breeding)	L	n
Waterfowl Group 9 (Migration)	M	n
Waterfowl Group 9 (Wintering)	L	n
Waterfowl Group 10 (Breeding)	L	n
Waterfowl Group 10 (Migration)	M	n
Waterfowl Group 11 (Breeding)	L	n
Waterfowl Group 11 (Migration)	L	n
Waterfowl Group 11 (Wintering)	L	n
Waterfowl Group 12 (Breeding)	L	n
Waterfowl Group 12 (Migration)	H	y
Waterfowl Group 12 (Wintering)	L	n
Waterfowl Group 13 (Breeding)	L	n
Waterfowl Group 13 (Migration)	L	n
Waterfowl Group 13 (Wintering)	L	n
Waterfowl Group 14 (Breeding)	L	n
Waterfowl Group 14 (Migration)	M	n
Waterfowl Group 14 (Wintering)	L	n
Green Heron	M	y

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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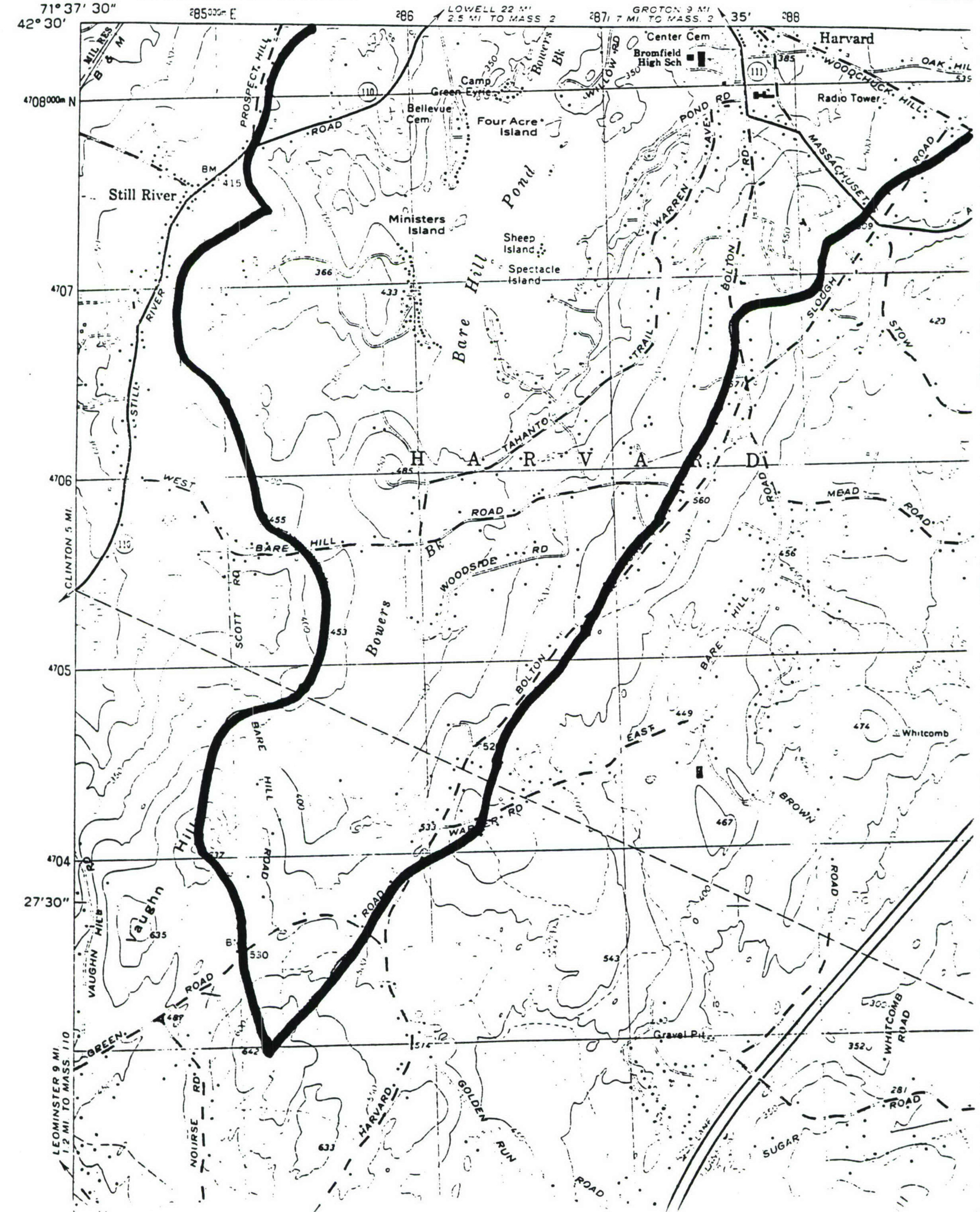

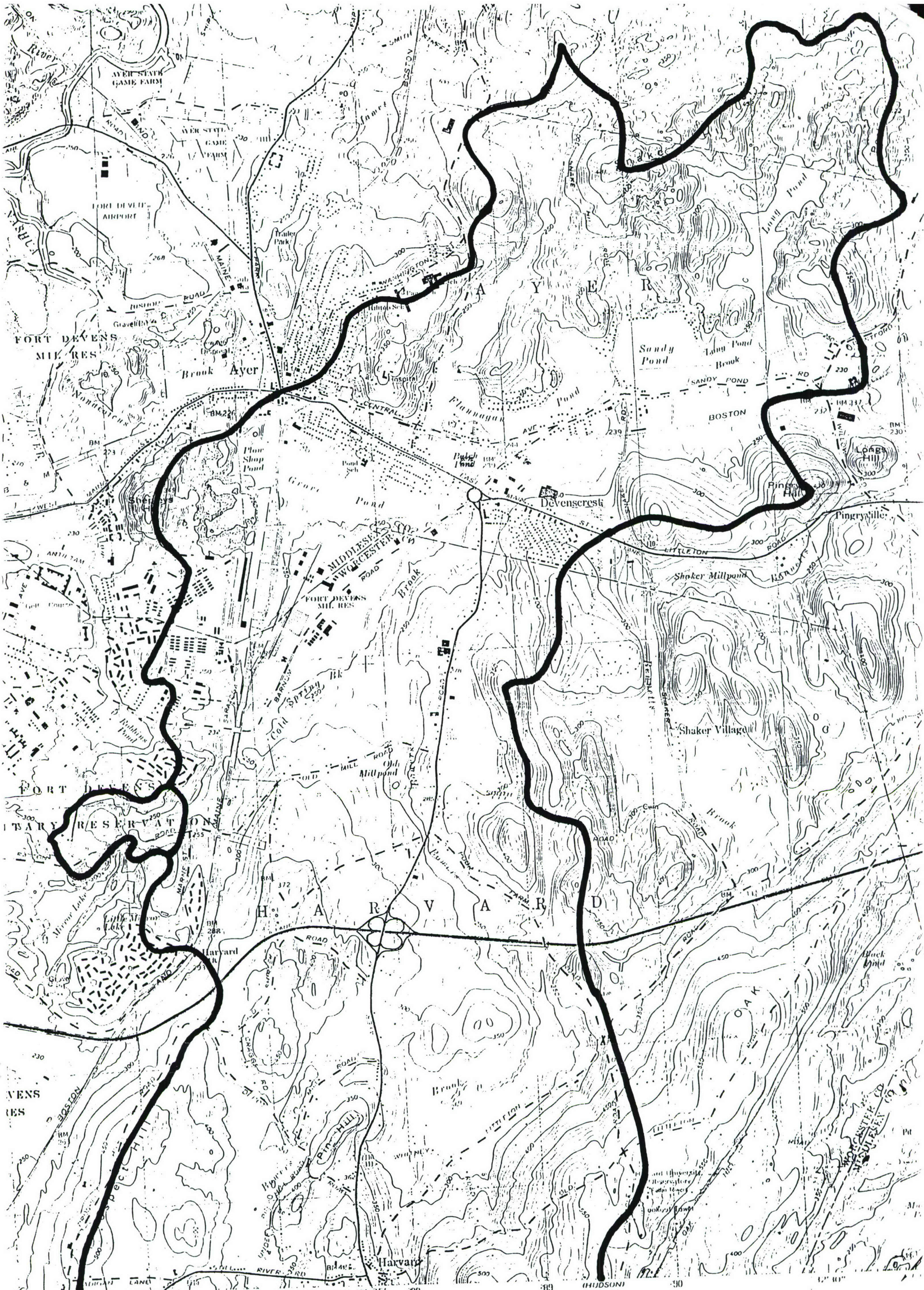

SCALE 1:25 000

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USC&GS, and Massachusetts Geodetic Survey
netable surveys 1923 and 1935. Revised 1966
n. 1927 North American datum
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CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929